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ABSTRACT

This publication compares first-generation students (i.e., those whose parents have no more than a high school education) with their peers whose parent or parents attended college. It focuses on mathematics course taking--the effectiveness of taking algebra in 8th grade and advanced math courses in high school for subsequent college enrollment--and planning strategies students used to prepare for college. The report also examines the involvement of students' parents, teachers, and other "institutional agents" capable of helping them prepare for college. The results of the study offer both negative and positive findings concerning the experiences of first-generation students. On the negative side, even after controlling for measures of academic achievement, family income, family structure (single versus two parents), and other related characteristics, first-generation students were less likely than their peers to participate in academic programs leading to college enrollment. Consequently, they were much less likely to enroll in college within two years of graduating from high school. The disparity between first-generation students and their peers from families where at least one parent had attained a bachelor's degree was especially notable. On the positive side, regardless of parents' educational attainment, students' achievement, and other related factors, students who completed mathematics programs beyond the level of Algebra 2 substantially increased their chances of enrolling in a 4-year college. In addition, other factors such as parents' participation in college preparation activities and students receiving help from their high school in the application process also increased students' chances of enrolling in college (at any level). (Contains 23 references.) (ASK)

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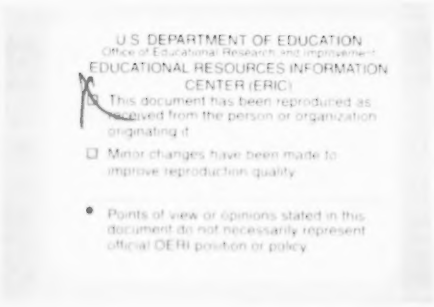
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Statistical Analysis Report March 2000

Postsecondary Education Descriptive Analysis Reports

Mapping the Road to College: First-Generation Students' Math Track, Planning Strategies, and Context of Support

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Executive Summary

College students whose parents have attained no more than a high school education are often referred to as "first-generation students." That is, they are the first generation in their immediate family to enroll in college. Increasing attention has been paid to this group of students as a means of increasing the diversity of college student populations. Because first-generation students cannot benefit from their parents' experiences in preparing for and applying to college, they may be at a distinct disadvantage in gaining access to postsecondary education. Thus, obtaining a better understanding of how to increase first-generation students' opportunities in preparing for college may help equalize their chances of benefiting from a college education.

This report compares the high school academic experiences of first-generation students with their peers from families where one or both parents have either some college education or are college graduates. Given the strong link between mathematics curricula and college enrollment (Riley 1997), the analysis of first-generation students' academic preparation focuses on mathematics course taking, beginning in the eighth grade. In addition, students' college planning activities and the extent to which parents and other key individuals are involved are examined.

The results of the study offer both negative and positive findings concerning the experiences of first-generation students. On the negative side, even after controlling for measures of academic achievement, family income, family structure (single versus two parents), and other related characteristics, first-generation students were less likely than their peers to participate in academic programs leading to college enrollment. Consequently, they were much less likely to enroll in college within two years of graduating from high school. The disparity between first-generation students and their peers from families where at least one parent had attained a bachelor's degree was especially notable.

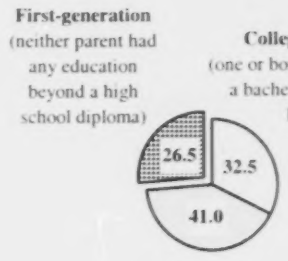
On the positive side, regardless of parents' educational attainment, students' achievement, and other related factors, students who completed mathematics programs beyond the level of algebra 2 substantially increased their chances of enrolling in a 4-year college. In addition, other factors such as parents' participation in college preparation activities and students receiving help from their high school in the application process also increased students' chances of enrolling in college (at any level).

First-Generation Students

Just over one-quarter (27 percent) of 1992 high school graduates were first-generation students (figure A). Half of first-generation students were from low-income families, in contrast to less than one-third of students whose parents had some postsecondary education and less than 1 in 10 students whose parents were college graduates.[1] Compared to students whose parents had bachelor's degrees or higher, first-generation students were more likely to be Hispanic or black (non-Hispanic).

[1]Whenever the term college graduates is used, it means at least one parent had attained a bachelor's degree.

Figure A—Percentage distribution of 1992 high school graduates, by first-generation status


First-generation
(neither parent had any education beyond a high school diploma)
College graduate
(one or both parents earned a bachelor's degree or higher)
26.5
32.5
41.0
Some college
(one or both parents attended postsecondary education, neither earned a bachelor's degree)

SOURCE: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study: 1988–94 (NELS:88/94), Data Analysis System.

Algebra in the Eighth Grade

Taking algebra in middle school is considered the "gateway" to completing advanced mathematics courses in high school (Oakes 1990). Yet just 14 percent of first-generation students took high school level algebra in the eighth grade, compared with 34 percent of students whose parents were college graduates (figure B). Even among eighth graders who were proficient at the highest mathematics level tested,[2] a lower proportion of first-generation students (34 percent) than of students whose parents were college graduates (55 percent) took algebra in the eighth grade.

High School Mathematics

At the high school level, first-generation students were far less likely to complete any advanced-level mathematics courses[3] (figure C). Even among those who were proficient at the highest level tested in the eighth grade, 63 percent of first-generation students completed at least one advanced mathematics course in high school, compared with 83 percent of students whose parents were college graduates.

However, if students took algebra in the eighth grade, they were more likely to complete advanced-level mathematics courses in high school. This was true regardless of parents' education and mathematics proficiency. For example, while nearly two-thirds (63 percent) of first-generation students who were proficient at the highest level of mathematics tested in the eighth grade had completed advanced high school mathematics courses, 83 percent who took algebra in the eighth grade had done so. Comparable percentages for students whose parents were college graduates were 83 and 95 percent, respectively. In other words, taking algebra in the eighth grade was associated with substantially higher rates of participation in advanced mathematics courses, even while controlling for mathematics proficiency and parents' education.

College Enrollment

The rate at which students completed advanced-level high school mathematics courses had a direct bearing on whether or not they enrolled in a 4-year college within two years of graduating from high school. The relationship was especially evident for first-generation students: nearly two-thirds (64 percent) who completed any advanced courses enrolled, compared with about one-third (34 percent) who completed courses through algebra 2. Comparable percentages for students whose parents graduated from college were 85 and 63 percent, respectively.

[2]Could perform simple problem solving requiring conceptual understanding or the development of a solution strategy.

[3]Any course beyond algebra 2 such as precalculus, calculus, trigonometry, probability, statistics, algebra 3, etc.

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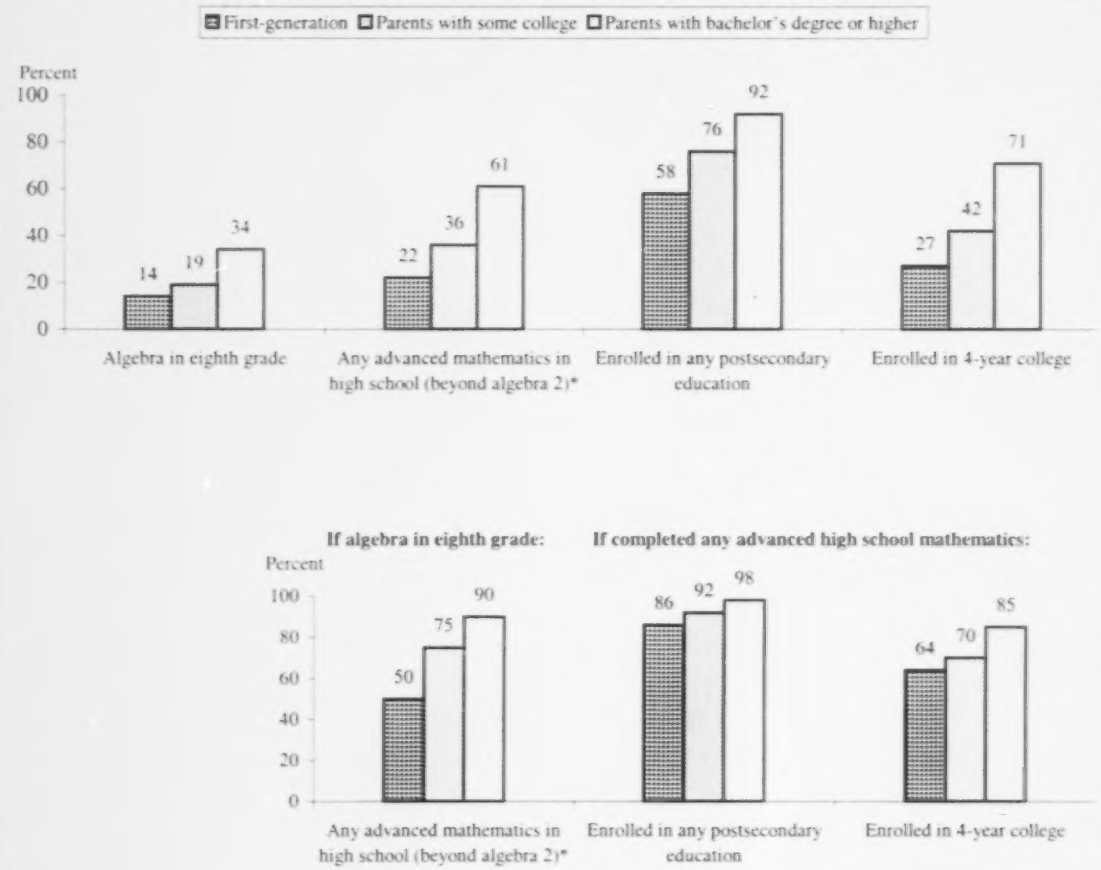
Figure B—Percentage of 1992 high school graduates participating in advanced mathematics curricula and the percentage enrolled in postsecondary education, by first-generation status



*Completed at least one class beyond algebra 2 labeled "advanced" including precalculus, calculus, trigonometry, probability, statistics, algebra 3, etc.

SOURCE: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study: 1988–94 (NELS 88/94), Data Analysis System.

Strong academic preparation, however, did not necessarily lead to college enrollment for all first-generation students. Two years after high school graduation, roughly one-quarter of first-generation students who were considered "highly qualified"[4] for admission to a 4-year college had not enrolled at the 4-year level, and 13 percent did not enroll in any postsecondary education. In contrast, just 1 percent of highly qualified students who had at least one parent with a bachelor's degree did not enroll in any postsecondary education. Thus, even for the most academically prepared students, first-generation students were less likely to enroll in

[4]They were in the top 10 percent of 1992 high school graduates who enrolled in 4-year colleges, according to a college qualification index based on five academic performance criteria (see appendix A for details).

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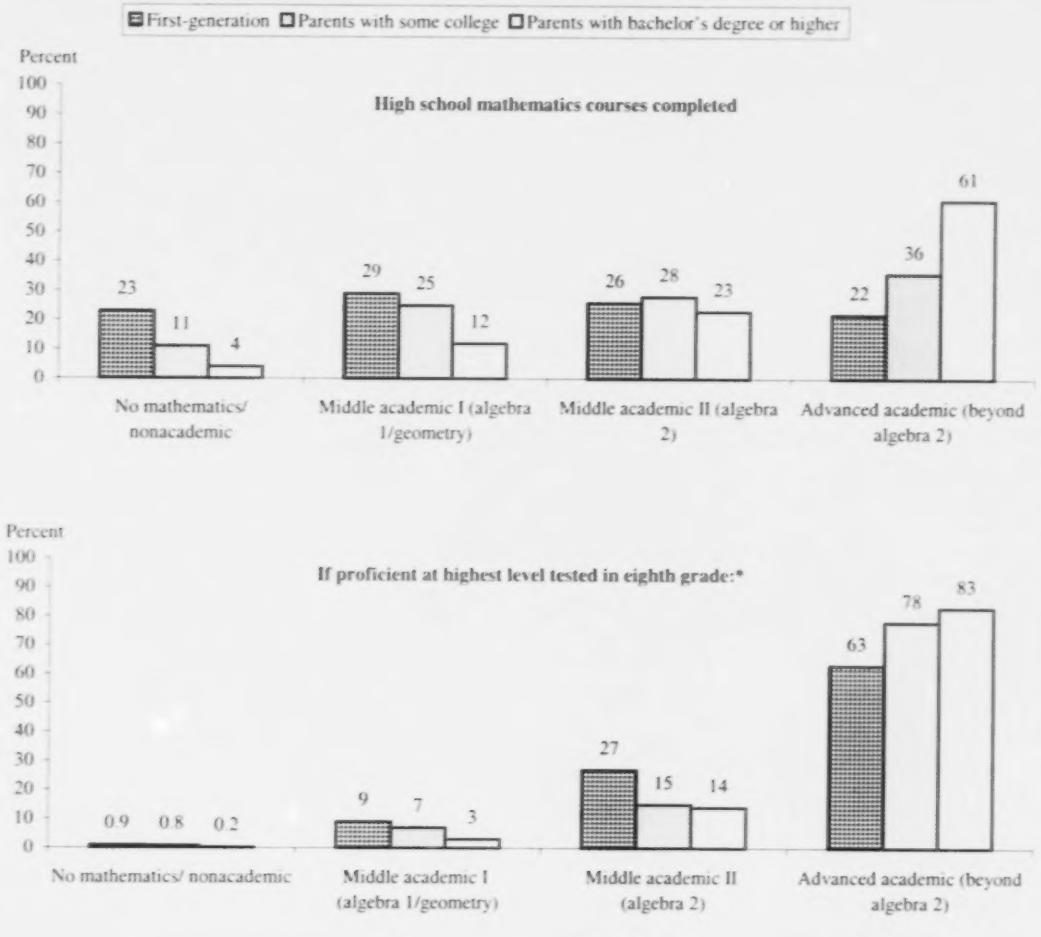
Figure C—Percentage distribution of 1992 high school graduates' highest level of mathematics courses completed in high school, by first-generation status



*Proficient at performing simple problem solving requiring conceptual understanding or the development of a solution strategy.

NOTE: Details may not sum to 100 due to rounding.

SOURCE: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study: 1988–94 (NELS:88/94), Data Analysis System.

postsecondary education. The remainder of the analysis examined factors that might help explain such discrepancies in enrollment outcomes.

Who Encourages Students

The involvement of parents and other key individuals such as teachers, counselors, school principals, close relatives, and friends in students' curricular choices was explored as a factor that might help explain differences in curricular in-

volvement and college enrollment patterns between first-generation and other students.

In Eighth Grade

Differences in parent involvement were apparent beginning in the eighth grade. As the level of parents' education increased, so did the proportion of eighth graders who reported that their parents encouraged them to take algebra in the eighth grade. Just under one-third (31 percent) of first-generation students reported that their parents wanted them to take algebra, compared with 39 percent of those whose parents had some college and 53 percent of those whose parents were college graduates. Even when controlling for proficiency in mathematics, differences by parents' education levels prevailed.

On the other hand, whether or not eighth graders reported being encouraged by teachers or school counselors to take algebra varied with their mathematics proficiency, not with their parents' education. For example, among first-generation students, 29 percent who performed below level 1 in mathematics proficiency[5] reported being encouraged by a teacher or counselor to take algebra in the eighth grade, compared with 47 percent who were proficient at the highest level of mathematics tested. Comparable percentages for students whose parents were college graduates were 33 percent and 54 percent, respectively.

In planning for their high school curriculum, eighth graders relied heavily on their mothers for guidance. Students were much more likely to report frequently discussing (i.e., three or more times) their future high school programs with their mothers than with their fathers (60 versus 43 percent). However, while frequent discussions with mothers varied little with parents' education, discussions with fathers increased as parents' highest education rose. About 34 percent of first-generation students, 41 percent of students whose parents had some college, and 50 percent of students whose parents were college graduates reported having frequent discussions with their fathers about their high school program.

Perhaps because they were more likely to come from single-parent homes, first-generation students reported frequently discussing their high school programs more often with their friends (49 percent) than with their fathers (34 percent). The same was not observed for students whose parents were college graduates; among these students, roughly half reported frequently discussing their high school programs with either their friends or fathers.

In High School

Confirming the results found in the eighth grade, when 1992 high school graduates were asked in the twelfth grade how they chose their high school programs, first-generation students were less likely than students whose parents were college graduates to report choosing their programs with their parents (34 versus 48 percent). At the same time, first-generation students were no more likely to report choosing their high school programs with a teacher or counselor, or with friends.

Planning for College

In understanding what is required for college admission and navigating the application process, first-generation students may receive little assistance from their parents who have had no direct experience in the process. Consequently, it might be expected that first-generation students would rely more on teachers, counselors, and other "knowledgeable agents" for guidance in applying to college. Yet, with two exceptions—getting

[5]Could not perform simple mathematical operations on whole numbers.

school assistance in applying for financial aid and obtaining counselors' assistance in choosing a twelfth-grade mathematics class—there was little evidence that first-generation students received help from the school more often than did students whose parents were college graduates. Moreover, the two instances in which first-generation students were more likely to receive school help came very late in their high school program.

Conclusions

The findings from this analysis indicate that first-generation students consistently trailed their counterparts whose parents were college graduates—and to some degree those whose parents had some college but less than a bachelor's degree—in participating in curricular activities linked to college enrollment. This remained true when controlling for academic preparation and other family background characteristics. That is, even high achieving first-generation students were less likely to take algebra in the eighth grade and less likely to complete advanced high school mathematics courses. Correspondingly, college-qualified first-generation students with academic credentials similar to those whose parents graduated from college enrolled in 4-year colleges and other types postsecondary education at lower rates than their counterparts.

However, when controlling for mathematics proficiency and parents' education, first-generation students increased their likelihood of completing advanced high school mathematics courses by taking algebra in the eighth grade (figure B). Taking advanced mathematics courses in high school, in turn, more than doubled their chances of enrolling in a 4-year college.

The data also indicated that parent involvement was strongly associated with students' taking algebra in eighth grade, advanced-level mathematics courses in high school, and in subsequent enrollment in postsecondary education. This remained true after controlling for parents' education, mathematics proficiency, and family background characteristics. Therefore, it is possible that providing first-generation students and their parents with more information about choosing courses to better prepare students for college might help these students better navigate the path to higher education.

Foreword

The report describes and analyzes the experiences of 1992 high school graduates who were "first-generation students"; that is, those whose parents have no more than a high school education. The analysis examines their mathematics course taking in relation to their subsequent college enrollment. The report also describes who students turned to for advice and encouragement for making decisions about their course taking.

The report uses data from the National Education Longitudinal Study of 1988 (NELS:88/94), a survey that began in 1988 with a nationally representative sample of eighth graders who were subsequently followed up every two years through 1994. The third follow-up survey was conducted two years after most of the cohort graduated from high school and provides information on their high school academic experiences, as well as their enrollment in postsecondary education. The information on mathematics course taking is based on high school transcript data.

The estimates presented in the report (mostly percentages) were produced using the NCES Data Analysis System (DAS) for the NELS:88/94 survey. The DAS is a microcomputer application that allows users to specify and generate their own tables. The DAS produces design-adjusted standard errors necessary for testing the statistical significance of differences shown in the tables. For more information regarding the DAS, readers should consult appendix B of this report.

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Introduction

There is a widespread perception that attaining a college degree is an effective means of raising the economic and social status of students from disadvantaged families. For example, among eighth graders in 1988, three-quarters of students whose families were in the lowest socioeconomic status (SES) quartile hoped to attain some postsecondary education, and about 42 percent aspired to a bachelor's degree (Sanderson, Dugoni, Rasinski, and Taylor 1996). Despite such aspirations, as of 1994, only about one-third (36 percent) of the low-SES students had enrolled in some kind of postsecondary education, compared with nearly 90 percent of those in the highest quartile (Sanderson, Dugoni, Rasinski, and Taylor 1996).

Recent research has shown that disadvantaged students often do not have the academic preparation necessary to pursue postsecondary education (Berkner and Chavez 1997; Horn 1997).[1] However, as these studies also showed, even academically prepared disadvantaged students were less likely than their more advantaged counterparts to take college entrance exams and to apply to college. What accounts for this difference? One obvious way that low-income students differ from their higher-income counterparts is the level of education their parents have attained. For example, among 1992 high school graduates, roughly one-half (47 percent) of low-income students' parents had no more than a high school education, compared with about 1 in 5 middle-income students and just over 1 in 20 high-income students (Berkner and Chavez 1997). The level of parents' education, in turn, may affect the amount of guidance parents can offer their children in preparing for higher education.

Students whose parents have no more than a high school education are often referred to as "first-generation" students. That is, those who enroll in college are the first generation in their immediate family to attend (Billson and Terry 1982; London 1989 and 1992; Terenzini, Springer, Yaeger, Pascarella, and Nora 1996; Nuñez and Cuccaro-Alamin 1998). Since first-generation students cannot benefit from their parents' direct experience in preparing for and applying to college, they may be at a distinct disadvantage with respect to gaining access to postsecondary education. Moreover, students whose parents are college educated are more aware of the importance of early academic preparation. For example, in interviews with parents of middle school students, Useem (1992) found that parents who had more education were more likely to influence

[1] Berkner and Chavez (1997) examined the experiences of low-income and minority students, and Horn (1998) examined the experiences of students considered at risk of dropping out of high school.

their children's placement in mathematics courses by ensuring that they were placed in more advanced mathematics tracks. There is also evidence of this pattern at the high school level. Among 1992 high school seniors, for example, students whose parents were college graduates were more likely than students whose parents had no more than a high school education to have completed the "New Basics" curriculum (Green, Bernard, Ingels, and Camburn 1995). Correspondingly, the level of parents' education is highly correlated with the college enrollment rates of their children. As of 1994, 41 percent of students whose parents had no more than a high school education had *not* enrolled in any postsecondary education, compared with about 8 percent of students whose parents were college graduates (Berkner and Chavez 1996).

The benefits of a higher education for first-generation students have been examined in a recent NCES report focusing on students just beginning their postsecondary education. The postsecondary experiences of first-generation students were compared with the experiences of students whose parents had more education (Nuñez and Cuccaro-Alamin 1998). The results of this study suggested that first-generation students who enrolled in postsecondary education and attained a postsecondary credential experienced similar early labor market outcomes as their non-first-generation counterparts. According to this study, among students who began their postsecondary education in 1989–90 and were followed up in 1994, first-generation students who had attained vocational certificates or college degrees were employed in similar positions and earned salaries comparable to their counterparts whose parents had attended college. Thus, postsecondary education appeared to be an equalizing factor, at least with respect to early employment outcomes.

Given the strong empirical evidence illustrating the benefits associated with higher education for first-generation students, understanding how these students make decisions about high school course taking and prepare themselves for higher education may help inform educators and policymakers about ways to increase these students' opportunities for pursuing postsecondary education. To examine first-generation students' path to college, students' academic experiences and planning for higher education are compared with those of their counterparts whose parents had more education. With respect to course taking, the analysis focuses specifically on mathematics. Many 4-year colleges and universities recommend or require advanced mathematics courses for admission. In order to prepare students for taking advanced courses, Oakes (1990) identified algebra and geometry as key "gateway" courses toward their taking higher level mathematics. At the same time, she also found that some secondary schools limit access to mathematics and science courses by placing minority students and those from lower socioeconomic backgrounds in lower track mathematics and science classes more often than their counterparts from higher socioeconomic backgrounds. This pattern has resulted in more limited

opportunities for these students to enroll in higher level mathematics courses and to enroll in college.

The importance of taking advanced mathematics in high school is highlighted in the title of a white paper issued by the U.S. Secretary of Education, Richard Riley (1997), "Mathematics Equals Opportunities." Findings from this report clearly demonstrate the link between mathematics course taking and going to college.

Report Organization

This report examines the mathematics curricula and college preparation activities of 1992 high school graduates, comparing first-generation students with students whose parents have more education. Because students' academic achievement and performance have been found to vary with parents' education, the analysis controls for academic ability while examining relationships to parents' education. For example, when analyzing mathematics coursework, students' mathematics proficiency in the eighth grade is held constant. Similarly, when examining high school experiences leading to college enrollment, students' high school mathematics curricula and whether or not they are qualified for admission to a 4-year college are held constant.

After providing a brief profile of first-generation students, this report addresses the following questions by comparing first-generation students to their counterparts whose parents have more education, while controlling for academic ability:

Starting Early

- Who took algebra in the eighth grade?
- If students took algebra in the eighth grade, who encouraged them to do so (parents, teachers, principals)?
- How likely were eighth graders to report the involvement of parents, teachers, guidance counselors, or other individuals in planning for their high school curriculum?

High School Mathematics

- Who took mathematics courses through the advanced level?
- Did completing advanced courses narrow the college enrollment gap between first-generation students and students whose parents had more education?

Planning for College

- How involved were parents, teachers, guidance counselors, and other individuals in assisting students in planning for college?
- Who got assistance from school personnel with college applications?

Going to College

- If first-generation students were academically prepared for admission to a 4-year college, did they enroll at the same rate as students with similar academic preparation whose parents had more education?

Data and Definitions

This analysis uses the Base-Year through the Third Follow-up survey files and the high school transcript files of the 1988 National Education Longitudinal Study (NELS:88). Follow-up surveys of NELS were conducted in 1990, 1992, and 1994, and parents, teachers, and school administrators were surveyed in 1988 and 1992. The Third Follow-up was conducted in 1994, when most of the participants had been out of high school for two years. Variables derived from high school transcript files were used to determine mathematics course taking in eighth grade and high school. The sample was limited to 1992 high school graduates.[2]

First-Generation Students

The main comparisons made throughout the report are across three levels of parents' highest education. Parents reported their highest level of education attained in the 1988 Base-Year survey. Education levels were aggregated as follows:

- *First-generation*: Both parents have no more than a high school education. Thus, the student would be a member of the first generation in the immediate family to attend college.
- *Some college*: One or both parents have some postsecondary education, but neither had attained a bachelor's degree. This category includes parents with vocational certificates and associate's degrees as the highest level of attainment.
- *College graduate*: One or both parents earned a bachelor's degree or higher.

Mathematics Course Taking

Algebra in the Eighth Grade

To determine whether or not students took the equivalent of high school algebra in the eighth grade, their high school transcripts were examined. If algebra 1 was not recorded on their

[2]First-generation students are much more likely than their peers whose parents attended college to drop out of high school (NELS:88/94 Data Analysis System). Including dropouts in this analysis would no doubt have increased the negative association between first-generation status and the outcomes measured. However, dropouts were not included because they would not have had the same time frame in which to take the mathematics courses examined in the study. In addition, there has been extensive research on dropouts (see, for example, Kaufman and Bradby), while research on disadvantaged high school graduates is more limited.

transcript and students took higher level courses (such as geometry or algebra 2), it was assumed that they completed algebra in the eighth grade or earlier. For those for whom transcripts were not available (roughly 15 percent), if students reported taking algebra in the eighth grade, they were coded as having done so.

High School Mathematics

In analyzing NELS high school transcript data, Lee, Burkham, Smerdon, Chow-Hoy, and Geverdt (1997) identified clusters of mathematics course-taking patterns that were closely correlated with academic achievement in mathematics as measured by NELS proficiency exams. In particular, they identified eight course-taking patterns that indicate increasing levels of advancement in the mathematics pipeline. These eight levels included (1) no mathematics, (2) nonacademic, (3) low academic, (4) middle academic I, (5) middle academic II, (6) advanced I, (7) advanced II (precalculus), and (8) advanced III (calculus). For this analysis, course-taking patterns were aggregated into four levels:

- *No mathematics, nonacademic, or low academic*: Student took no mathematics or only nonacademic courses (general mathematics or basic skills mathematics), or low-academic courses including preliminary (e.g., pre-algebra) or reduced rigor/paced courses such as algebra 1 spread over two years or "informal geometry." This category is often referred to as "nonacademic" throughout the report.
- *Middle academic I*: Completed two years of mathematics including algebra 1 and geometry or two years of unified mathematics.
- *Middle academic II*: An additional year of mathematics was completed including algebra 2 or a third year of unified mathematics.
- *Advanced*: Took at least one of any courses labeled "advanced" including precalculus, calculus, trigonometry, probability, statistics, introductory analysis, or algebra 3.

Measures of Mathematics Ability and Academic Preparation

Eighth-Grade Mathematics Proficiency

The analysis controls for eighth-grade mathematics ability using proficiency test scores. Proficiency is defined as follows: (The percentage of 1992 high school graduates performing at these levels in the eighth grade is shown in parentheses.)

- *Below Level 1*: Cannot perform at level 1 proficiency (13 percent).
- *Level 1*: Can perform simple arithmetical operations on whole numbers, but below level 2 (37 percent).

- *Level 2*: Can perform simple operations with decimals, fractions, and roots, but cannot perform at level 3 (25 percent).
- *Level 3*: Can perform at lower levels and can do simple problem solving, requiring conceptual understanding or the development of a solution strategy (24 percent).

Index of Academic Qualification for College Admission

To determine how academically prepared high school seniors were to enroll in college, a college qualification index originally developed by Berkner and Chavez (1997) was used. The index is based on five academic performance measures: high school cumulative GPAs, senior class rank, the NELS 1992 composite test score, and the SAT and ACT college entrance examination scores. Since admission standards and requirements vary widely among 4-year colleges and universities, the index was based on the actual distribution of these five measures of academic aptitude and achievement among those graduating seniors who attended a 4-year college or university. Data sources were available for approximately half (45 percent) of the NELS graduating seniors for four or five of the criteria: class rank, GPA, the NELS test, and SAT or ACT scores or both. For about one-third of the seniors, there were only three data sources available because they had no SAT or ACT scores. All of these seniors had NELS test scores, however. In order to identify as many students as possible who were potentially academically qualified for a 4-year college, the seniors were classified according to the highest level they had achieved on any of the five criteria for which data were present (see appendix A under entry for "CQCOMV2" for more detail).

For this report, the categories "minimal" and "somewhat" qualified were combined.

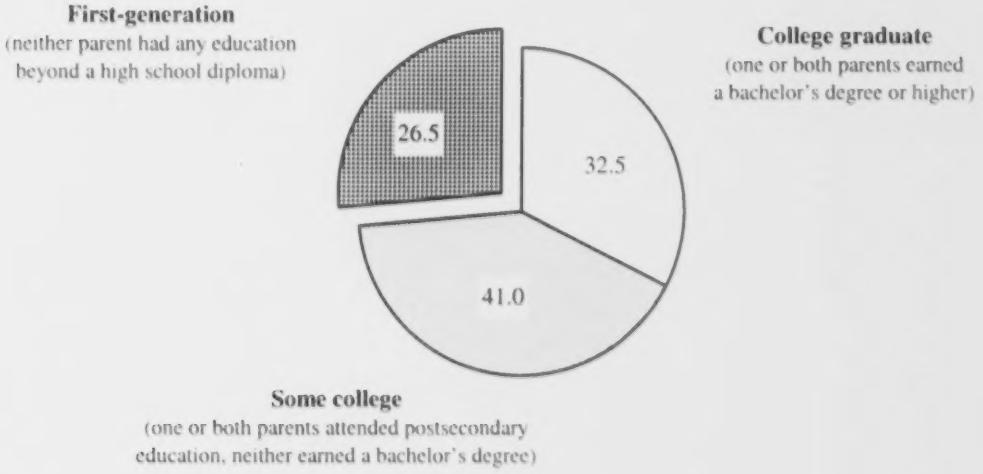
- *Highly qualified*: Those whose highest value on any of the five criteria would put them among the top 10 percent of 4-year college students (specifically the NELS 1992 graduating seniors who enrolled in 4-year colleges and universities) for that criterion. Minimum values were GPA=3.7, class rank percentile=96, NELS test percentile=97, combined SAT=1250, composite ACT=28.
- *Very qualified*: Those whose highest value on any of the five criteria would put them among the top 25 percent of 4-year college students for that criterion. Minimum values were GPA=3.6, class rank percentile=89, NELS test percentile=90, combined SAT=1110, composite ACT=25.
- *Minimally to somewhat qualified*: Those whose highest value on any of the five criteria would put them either among the top 75 percent (minimally qualified) or the top 50 percent (somewhat qualified) of 4-year college students for that criterion. Minimum values were GPA=2.7, class rank percentile=54, NELS test percentile=56, combined SAT=820, composite ACT=19.

- *Marginally or not qualified*: Those who had no value on any criterion that would put them among the top 75 percent of 4-year college students (i.e., all values were in the lowest quartile). In some instances, either because of missing data or because students were considered to be special admissions, roughly 10 percent of students who were identified as not qualified had enrolled in 4-year institutions.

Profile of First-Generation High School Students

Just over one-quarter (27 percent) of 1992 high school graduates were identified as "first-generation" students (figure 1). These students had particular demographic characteristics that distinguished them from other students (table 1 and figure 2). For example, compared with students whose parents were either college graduates or had some college education, first-generation students were more likely to be Hispanic (14 percent versus 8 and 4 percent, respectively). First-generation students were also more likely than students whose parents were college graduates (but not more likely than those whose parents had some college) to be black, non-Hispanic (16 percent versus 6 percent) and to be female (53 percent versus 48 percent). The gender difference may be due in part to the fact that males either drop out of high school or complete high school by earning a GED more often than females (Sanderson, Dugoni, Rasinski, and Taylor 1996).

Figure 1—Percentage distribution of 1992 high school graduates, by first-generation status


First-generation
(neither parent had any education beyond a high school diploma)
26.5
College graduate
(one or both parents earned a bachelor's degree or higher)
32.5
41.0
Some college
(one or both parents attended postsecondary education, neither earned a bachelor's degree)

NOTE: Details may not sum to 100 due to rounding.

SOURCE: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study: 1988–94 (NELS:88/94), Data Analysis System.

Table 1—Percentage distribution (by columns) of 1992 high school graduates' gender, race/ethnicity, family composition, and family income, by first-generation status

	Parents' highest education level			
	First-generation	Some college	College graduate	Total
Total	100.0	100.0	100.0	100.0
Gender				
Male	47.2	49.1	52.0	49.4
Female	52.8	50.9	48.0	50.6
Race/ethnicity				
Asian/Pacific Islander	3.9	3.3	7.0	4.6
Hispanic	14.1	7.8	3.8	9.5
Black, non-Hispanic	15.9	13.8	6.2	10.9
White, non-Hispanic	65.1	74.0	82.7	74.1
American Indian/Alaskan Native	1.1	1.1	0.4	1.0
Family composition in 1988				
Both parents	65.3	70.1	82.7	72.1
Parent and guardian	12.2	14.3	8.6	12.3
Single parent	22.5	15.7	8.7	15.6
Family income in 1991				
Low (less than $25,000)	51.3	29.2	8.3	28.1
Middle ($25,000–74,999)	45.8	64.9	56.9	57.3
High ($75,000 or more)	3.0	56.9	34.8	14.6

NOTE: Details may not sum to 100 due to rounding.

SOURCE: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study: 1988–94 (NELS:88/94), Data Analysis System.

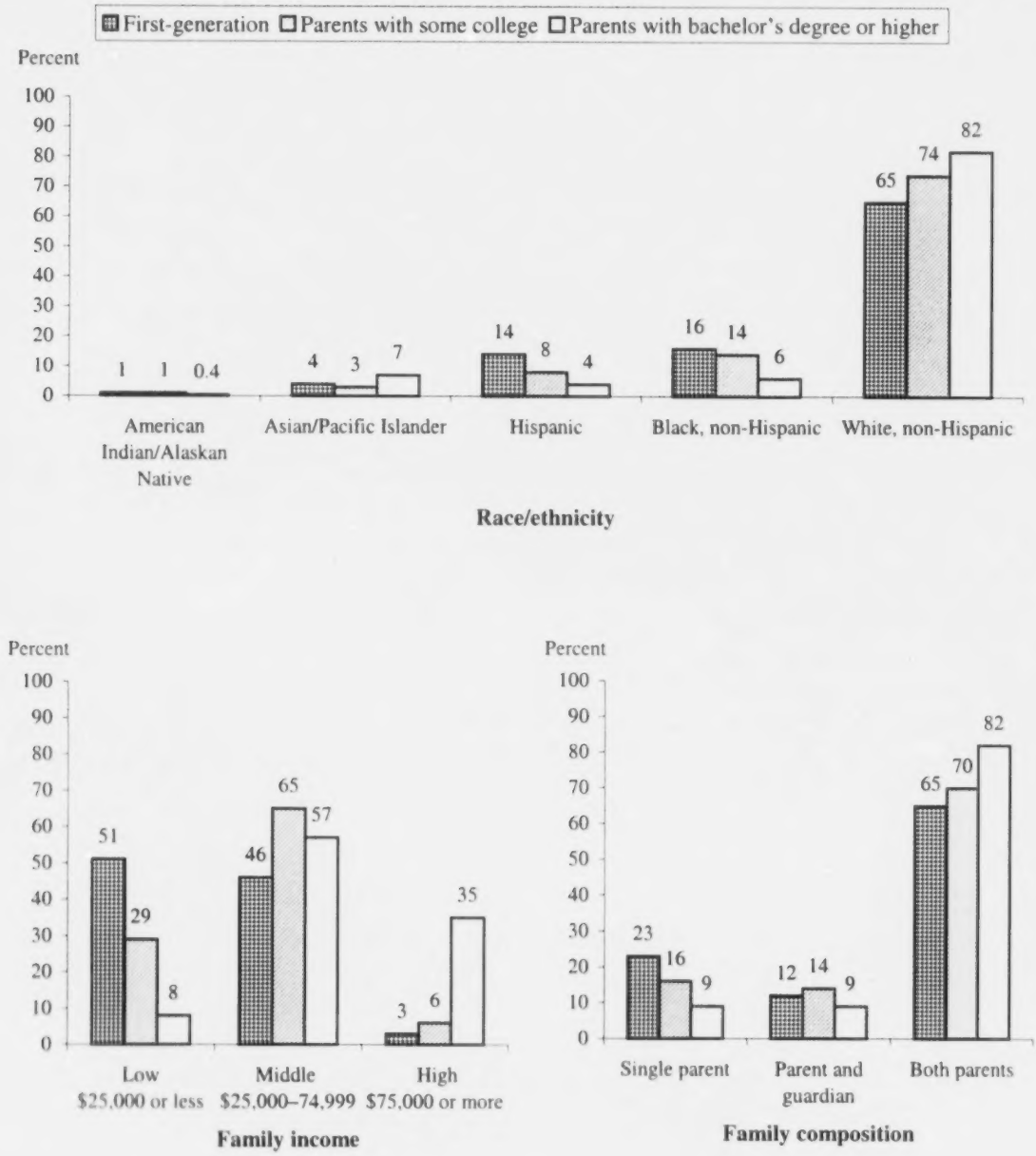
Family characteristics of first-generation students also differed from those of their non-first-generation counterparts. As parents' education rose, the likelihood that students' family income was in the lowest income quartile declined sharply (51 percent of first-generation students, 29 percent of those whose parents had some college, and 8 percent of those whose parents were college graduates). Similarly, as parents' education increased, the likelihood of being from a single-parent home also declined, from 23 percent of first-generation students, to 16 percent of those whose parents had some college, to 9 percent of those whose parents were college graduates.

Educational Aspirations

When surveyed as eighth graders in 1988, first-generation students had relatively high educational aspirations:[3] 42 percent aspired to a bachelor's degree, and 13 percent aspired to an ad-

[3]Students were asked about their future plans in each survey with the question: "As things stand now, how far do you think you will get?" They were given a detailed list of education levels, which were aggregated in this study as shown in tables.

Figure 2—Percentage distribution of 1992 high school graduates' race/ethnicity, family income, and family composition, by first-generation status



NOTE: Details may not sum to 100 due to rounding.

SOURCE: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study: 1988–94 (NELS:88/94), Data Analysis System.

vanced degree (table 2). An additional 30 percent aspired to some college or vocational school, and 16 percent thought a high school diploma was as far as they would go. Despite such aspirations, first-generation students were less likely than students whose parents had some college or a bachelor's degree to indicate that the highest degree they planned to attain was a bachelor's degree and were less likely to aspire to an advanced degree. Moreover, as parental education increased, students were less likely to report that they aspired to no more than a high school diploma or that they expected to attain some college or vocational school.

When they were followed up as sophomores in 1990, first-generation students continued to differ significantly from their counterparts whose parents had more education with respect to the highest degree they expected to attain. First-generation students (29 percent) remained less likely than students whose parents had some college (37 percent) or a bachelor's degree (40 percent) to indicate that they expected to attain a bachelor's degree. Similar patterns emerged for the likelihood of aspiring to an advanced degree. Proportionally, more than twice as many students whose parents were college graduates (46 percent) as first-generation students (17 percent) expected to earn advanced degrees. At the lower end of the spectrum, as parental education increased, the proportion of students whose highest aspiration was a high school diploma or a sub-baccalaureate credential declined. Between 1988 and 1990, the percentage of first-generation students who aspired to earn a bachelor's degree declined from 42 to 29 percent, while the percentage who aspired to attend some college or attain a vocational credential increased (from 30 to 40 percent).

Table 2—Percentage distribution of 1992 high school graduates' educational expectations in 1988 and in 1992, by first-generation status

	Expectations in 1988				Expectations in 1990			
	No post-secondary education	Some college or voc. training	Bachelor's degree	Advanced degree	No post-secondary education	Some college or voc. training	Bachelor's degree	Advanced degree
Total	7.3	19.9	47.4	25.5	6.6	27.9	35.5	30.0
First-generation status								
First-generation student	15.6	29.6	42.3	12.6	13.7	39.8	29.4	17.2
Parents have some college	6.2	23.1	50.0	20.8	5.5	30.8	36.9	26.7
Parents have bachelor's or advanced degree	1.4	7.7	48.4	42.6	1.5	12.9	39.9	45.7

NOTE: Details may not sum to 100 due to rounding.

SOURCE: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study: 1988–94 (NELS:88), Data Analysis System.

Where They Attended High School

As shown in table 3, first-generation students were less likely than students whose parents had college degrees to attend suburban schools (36 versus 47 percent). It also appears that students whose parents had some college were less likely than those whose parents had bachelor's degrees to attend suburban high schools (40 versus 47 percent), however, there is not enough statistical evidence to conclude that they differ. Conversely, first-generation students (39 percent) and students whose parents had some college (34 percent) were more likely than students whose parents were college graduates (22 percent) to be enrolled in rural high schools.

Table 3—Percentage distribution of 1992 high school graduates' school location, by first-generation status

	School location in 1992		
	Urban	Suburban	Rural
Total	27.3	41.8	30.9
Parents' highest education			
First-generation student	25.5	35.5	39.0
Parents have some college	26.3	40.0	33.7
Parents have bachelor's or advanced degree	30.8	47.0	22.3

NOTE: Details may not sum to 100 due to rounding.

SOURCE: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study: 1988–94 (NELS:88), Data Analysis System.

The Mathematics Track to College

The advantage of getting an early start in learning high school mathematics has been clearly demonstrated in earlier research. For example, Oakes (1990) has shown that taking algebra in middle school opens the "gateway" to completing advanced mathematics courses in high school. Completing advanced mathematics courses in high school, in turn, is highly valued if not required for admission to many 4-year colleges and universities. Taking advanced mathematics and science in high school is also critical for entering science and engineering fields of study in college.

Algebra in the Eighth Grade

The findings of this study clearly illustrate the relationship between taking high school-level algebra in the eighth grade and subsequent enrollment in higher level mathematics courses in high school. Just over one-fifth (22 percent) of 1992 high school graduates took high school-level algebra in the eighth grade (table 4). When examining the relationship between taking algebra in the eighth grade and parents' education levels, it was evident that there was a sharp increase in participation as parents' education rose. Students whose parents were college graduates were at least twice as likely as first-generation students to take algebra in the eighth grade (34

Table 4—Percentage of 1992 high school graduates who took high school-level algebra in the eighth grade, by first-generation status and eighth-grade mathematics proficiency

	First-generation	Some college	Bachelor's degree or higher	Total
Total	14.1	19.4	33.5	22.3
Mathematics proficiency in 1988*				
Below level 1	9.3	8.0	12.1	9.1
Level 1	10.9	10.7	15.1	11.8
Level 2	15.5	20.6	23.9	20.6
Level 3	33.8	47.3	54.9	49.7

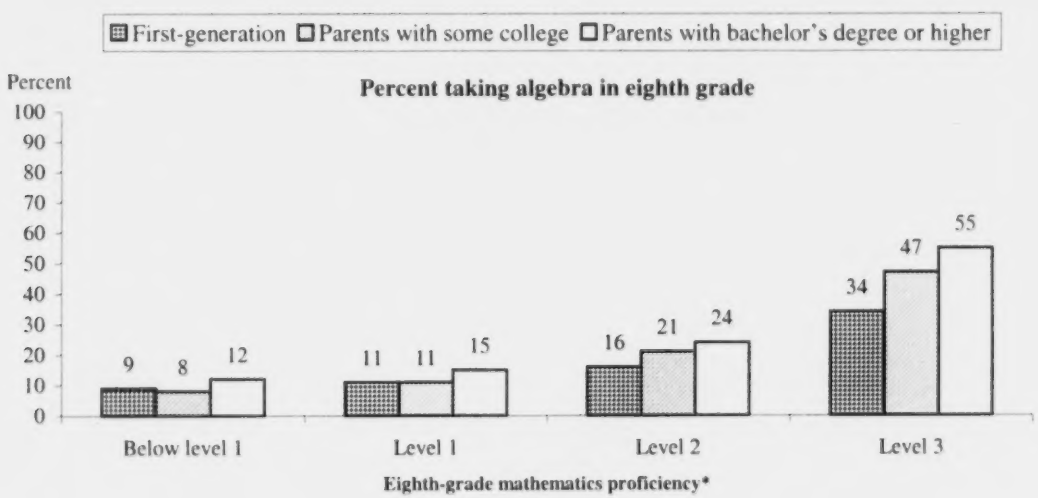
*Level 1: Can perform simple arithmetical operations on whole numbers. Level 2: Can perform simple operations with decimals, fractions, roots. Level 3: Can perform simple problem solving requiring conceptual understanding or the devlopment of a solution strategy.

SOURCE: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study: 1988–94 (NELS:88), Data Analysis System.

versus 14 percent). The rate of participation for students whose parents had some college education fell between the rates of the two other groups—they were more likely than first-generation students but less likely than students whose parents had bachelor's degrees or higher to take algebra in the eighth grade (19 percent).

At the same time, the likelihood that students were proficient in mathematics when tested in the eighth grade also varied with parents' education levels.[4] Therefore, it is important to take into account eighth-grade mathematics proficiency when determining the relationship between parents' education and students' likelihood of taking algebra in the eighth grade. In doing so, as shown in figure 3, there were no measurable differences across the three levels of parents' education in the likelihood of taking algebra in the eighth grade for students performing at or below level 1 proficiency (performing simple operations on whole numbers). However, among students who tested higher and, thus, were more capable of taking algebra in eighth grade, there were

Figure 3—Percentage of 1992 high school graduates who took algebra 1 in the eighth grade, by eighth-grade mathematics proficiency and first-generation status



*Level 1: Can perform simple arithmetical operations on whole numbers. Level 2: Can perform simple operations with decimals, fractions, roots. Level 3: Can perform simple problem solving requiring conceptual understanding or the development of a solution strategy.

SOURCE: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study: 1988–94 (NELS:88/94), Data Analysis System.

[4]National Education Longitudinal Study 1988–94 Data Analysis System.

obvious differences relative to parents' education. For instance, among students who were proficient at the highest level tested, approximately one-third (34 percent) of first-generation students took algebra in the eighth grade, compared with nearly one-half (47 percent) of students whose parents had some college and 55 percent of students whose parents had bachelor's degrees or higher. In other words, among the most academically promising students, first-generation students' chances of completing advanced mathematics courses in high school were substantially reduced in relation to students whose parents had more than a high school education.

High School Mathematics

The disparity between first-generation students' participation in higher level mathematics and that of their counterparts whose parents were college graduates was even more apparent at the high school level. Just over one-fifth (22 percent) of first-generation students had completed any advanced mathematics courses (beyond algebra 2) in high school, compared with almost two-thirds (61 percent) of students whose parents were college graduates (table 5). This was true also when controlling for eighth-grade mathematics proficiency; as parents' education rose, so did the proportion of students who completed advanced mathematics courses in high school.[5] For example, as shown in figure 4, among students who were proficient at level 3 in eighth grade mathematics, 63 percent of first-generation students, 78 percent of students whose parents had some college, and 83 percent of students whose parents had bachelor's degrees had completed advanced mathematics courses in high school.

Comparing tables 5 and 6, one can see the advantage of taking algebra in the eighth grade with respect to completing advanced-level mathematics courses in high school. While one-fifth of all first-generation students had completed any advanced mathematics courses in high school, one-half of those who had taken algebra in the eighth grade had done so. When looking only at first-generation students who were proficient at the highest level tested in the eighth grade, 63 percent of all first-generation students had completed advanced mathematics courses in high school, compared with 83 percent of those who had taken algebra in the eighth grade (figure 5). This difference indicates the importance of first-generation students having access to algebra in the eighth grade. Yet, as illustrated in figure 6, one-fifth of first-generation students who were proficient at the highest level tested reported that algebra was not offered in their school, compared with one-tenth of their counterparts whose parents were college graduates.

[5]The one exception was among students performing below level 1, among whom first-generation students and those whose parents had some college did not differ in their likelihood of taking advanced mathematics in high school (7 percent and 8 percent, respectively).

Table 5—Percentage distribution of 1992 high school graduates' highest level of mathematics courses completed in high school, by first-generation status and eighth-grade mathematics proficiency

	Mathematics course sequence			
	No mathematics/ low or nonacademic	Middle academic I (algebra 1 and geometry)	Middle academic II (algebra 2)	Advanced academic (beyond algebra 2)[1]
Total	12.3	22.3	26.1	39.3
Mathematics proficiency in 1988[2]				
Below level 1	31.3	35.9	20.5	12.3
Level 1	15.3	32.0	30.9	21.8
Level 2	5.5	15.5	32.7	46.3
Level 3	0.6	4.9	16.3	78.2
First-generation				
Total	23.0	29.4	26.0	21.7
Below level 1	40.7	34.9	17.6	6.9
Level 1	24.7	34.8	25.7	14.8
Level 2	10.4	22.0	35.3	32.3
Level 3	0.9	9.4	27.2	62.6
Parents have some college				
Total	11.1	24.8	27.7	36.4
Below level 1	32.9	39.7	19.3	8.1
Level 1	11.6	33.1	32.5	22.8
Level 2	6.1	16.6	34.4	43.0
Level 3	0.8	6.7	14.9	77.6
Parents have bachelor's or advanced degree				
Total	3.8	11.6	23.2	61.4
Below level 1	11.6	24.4	28.4	35.6
Level 1	7.8	25.0	31.8	35.4
Level 2	1.1	8.6	27.9	62.4
Level 3	0.2	2.6	14.0	83.2

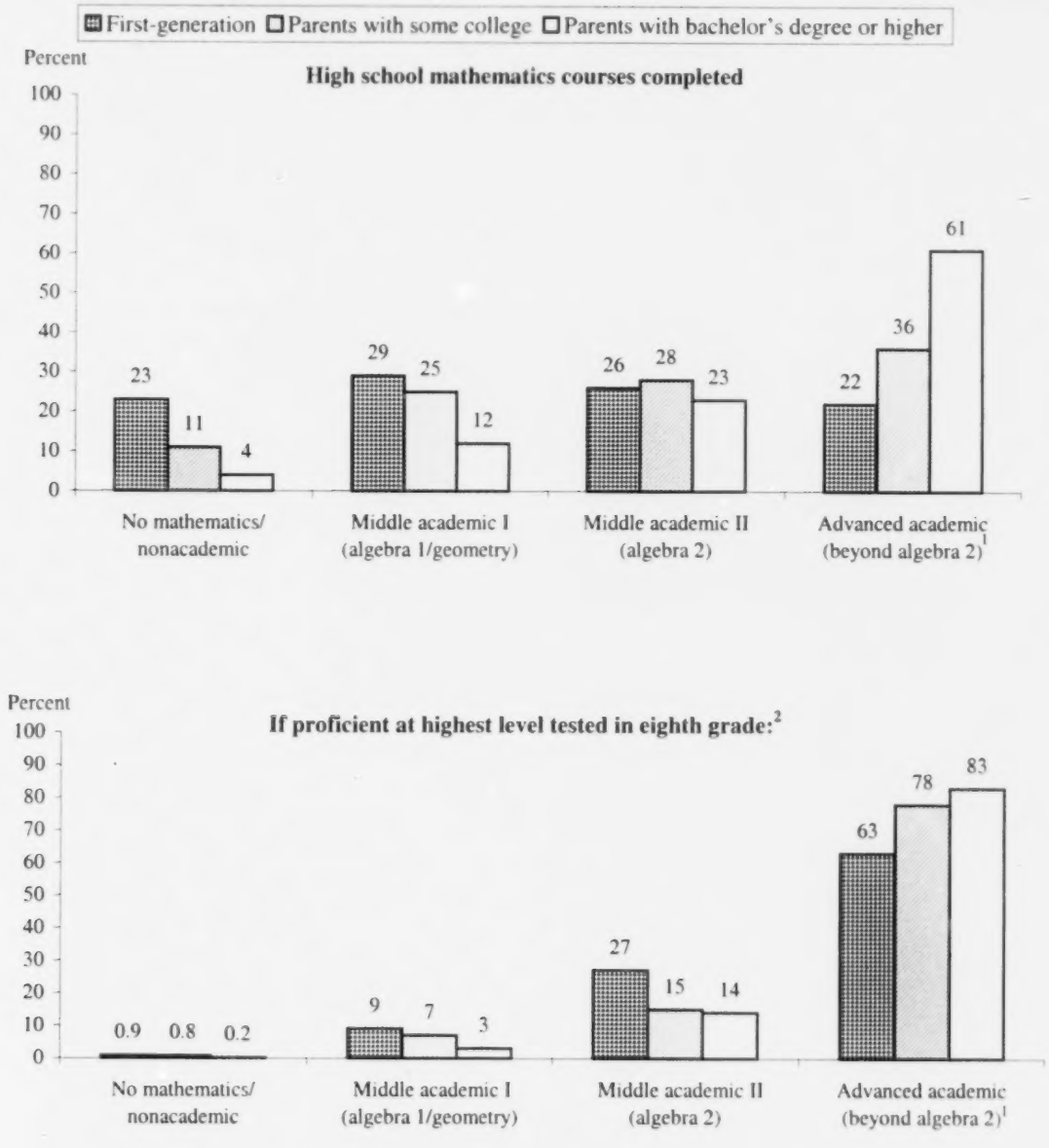
[1]Completed at least one class beyond algebra 2 labeled "advanced" including precalculus, calculus, trigonometry, probability, statistics, algebra 3, etc.

[2]Level 1: Can perform simple arithmetical operations on whole numbers. Level 2: Can perform simple operations with decimals, fractions, roots. Level 3: Can perform simple problem solving requiring conceptual understanding or the devlopment of a solution strategy.

NOTE: Details may not sum to 100 due to rounding.

SOURCE: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study: 1988–94 (NELS:88), Data Analysis System.

Figure 4—Percentage distribution of 1992 high school graduates' highest level of mathematics courses completed in high school, by first-generation status



[1]Completed at least one class beyond algebra 2 labeled "advanced",including precalculus, calculus, trigonometry, probability, statistics, algebra 3, etc.

[2]Proficient at performing simple problem solving requiring conceptual understanding or the development of a solution strategy.

NOTE: Details may not sum to 100 due to rounding.

SOURCE: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study: 1988–94 (NELS:88/94), Data Analysis System.

Table 6—Percentage distribution of 1992 high school graduates who took algebra in the eighth grade, by highest level of mathematics courses completed in high school, first-generation status, and eighth-grade mathematics proficiency

	Mathematics course sequence			
	No mathematics/ low or nonacademic	Middle academic I (algebra 1 and geometry)	Middle academic II (algebra 2)	Advanced academic (beyond algebra 2)[1]
		Took algebra in eighth grade		
Total	0.6	8.8	12.8	77.8
Mathematics proficiency in 1988[2]				
Below level 1	5.2	48.6	24.7	21.5
Level 1	2.3	27.1	25.6	45.0
Level 2	0.8	5.9	18.8	74.6
Level 3	0.0	0.8	6.1	93.2
		First-generation		
Total	3.2	19.8	27.2	49.8
Below level 1	—	—	—	—
Level 1	4.5	28.9	23.1	43.6
Level 2	2.6	10.7	30.0	56.8
Level 3	0.0	3.4	14.1	82.5
		Parents have some college		
Total	0.5	11.3	13.5	74.7
Below level 1	—	—	—	—
Level 1	2.3	37.1	25.1	35.5
Level 2	1.0	6.4	25.0	67.6
Level 3	0.0	1.3	6.1	92.6
		Parents have bachelor's or advanced degree		
Total	0.0	2.3	7.8	89.9
Below level 1	—	—	—	—
Level 1	0.0	8.2	26.6	65.2
Level 2	0.0	3.3	9.3	87.4
Level 3	0.0	0.2	5.3	94.5

— Too few cases for reliable estimate.

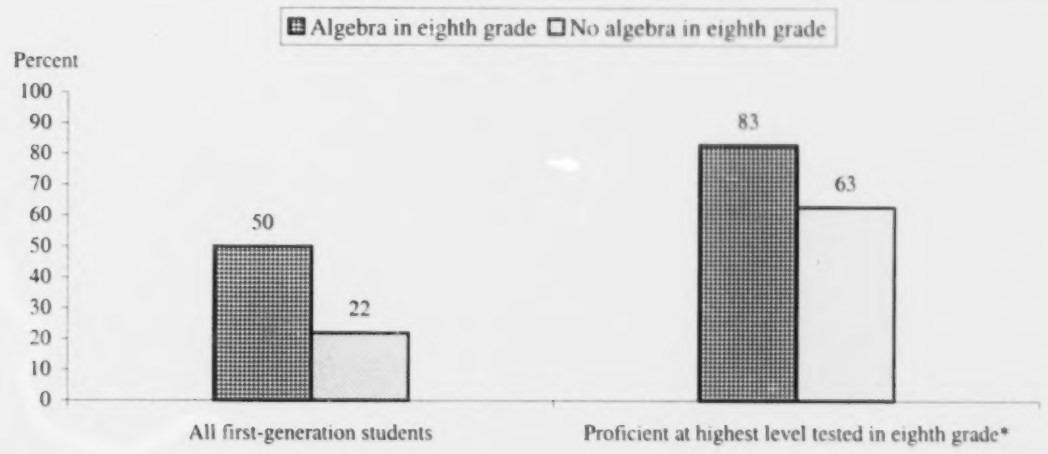
[1]Completed at least one class beyond algebra 2 labeled "advanced" including precalculus, calculus, trigonometry, probability, statistics, algebra 3, etc.

[2]Level 1: Can perform simple arithmetical operations on whole numbers. Level 2: Can perform simple operations with decimals, fractions, roots. Level 3: Can perform simple problem solving requiring conceptual understanding or the development of a solution strategy.

NOTE: Details may not sum to 100 due to rounding.

SOURCE: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study: 1988–94 (NELS:88), Data Analysis System.

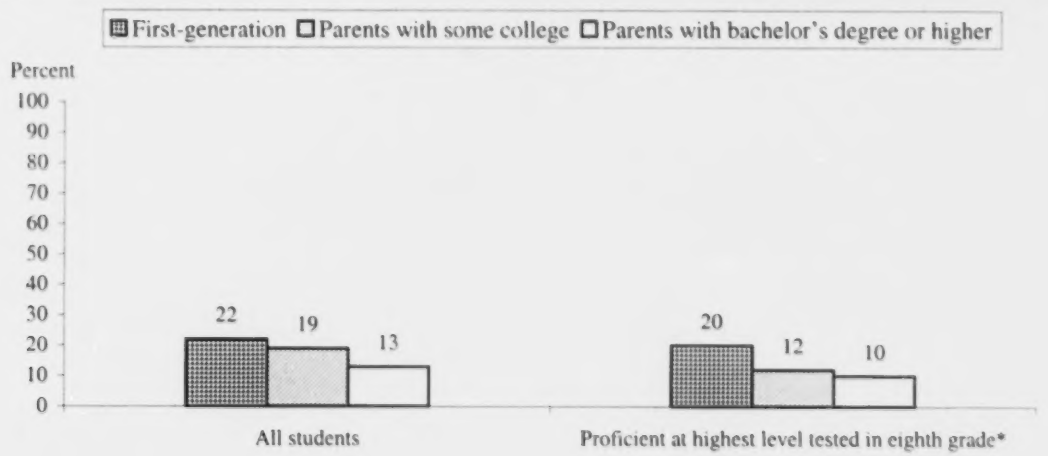
Figure 5—Percentage of first-generation 1992 high school graduates who completed any advanced mathematics courses (beyond algebra 2) in high school, by their participation in eighth-grade algebra



*Proficient at performing simple problem solving requiring conceptual understanding or the development of a solution strategy.

SOURCE: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study: 1988–94 (NELS:88/94), Data Analysis System.

Figure 6—Percentage of 1992 high school graduates who reported that algebra was not offered by their school in eighth grade, by first-generation status and mathematics proficiency



*Proficient at performing simple problem solving requiring conceptual understanding or the development of a solution strategy.

SOURCE: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study: 1988–94 (NELS:88/94), Data Analysis System.

Even after taking into account the advantage of completing algebra in the eighth grade, the level of parents' education was associated with completing advanced mathematics courses in high school. As shown in table 6, this was especially evident for students who were proficient at level 2 *and* had taken algebra in eighth grade. Among these students, 57 percent of first-generation students had taken advanced-level mathematics courses in high school, compared with 87 percent of students whose parents were college graduates. There also appeared to be a similar pattern among those who were proficient at level 3 mathematics in eighth grade: 83 percent of first-generation students and 95 percent of students whose parents were college graduates had completed advanced mathematics courses. But due to small sample sizes, there is not enough statistical evidence to conclude that the proportions of the two groups are different.[6]

College Qualification and Enrollment

The relationship between completing any advanced mathematics courses in high school and whether or not a student was qualified for and subsequently enrolled in college was strong and compelling. The results illustrate an obvious threshold of college qualification levels between students who took advanced mathematics courses with those who completed courses through algebra 2 or lower (table 7). Among students who completed courses through algebra 2 but completed no advanced courses, just one-quarter were either very (19 percent) or highly (6 percent) qualified for admission, compared with 70 percent of students who completed advanced mathematics courses; among whom, 35 percent were very qualified and 35 percent were highly qualified. In turn, these differences are reflected in 4-year college enrollment rates (table 8). Among students who completed advanced mathematics courses, 76 percent enrolled, compared with 44 percent of students completing courses through algebra 2.[7]

The advantage of taking advanced mathematics courses was particularly evident for first-generation students (figure 7). Those who completed any advanced mathematics courses in high school enrolled in 4-year colleges at nearly double the rate as those who completed mathematics courses through algebra 2 (64 versus 34 percent). At the same time, even when taking into account the level of mathematics courses taken in high school, parents' education was still associated with college qualification and enrollment. The contrast was particularly evident among students who completed mathematics courses through algebra 2. Among these students, those whose parents were college graduates were nearly twice as likely as first-generation students to enroll in 4-year colleges (63 versus 34 percent). Just over 40 percent of students whose parents

[6]Significant at the 0.1 level.

[7]These results are consistent with a recently published study showing that taking one course above the level of algebra 2 in high school was associated with a sharp increase in completing a bachelor's degree (from 40 to 62 percent) among 1982 high school graduates (Adelman 1999 table 6).

Table 7—Percentage distribution of 1992 high school graduates' 4-year college qualification index,[1] by first-generation status and the highest level of mathematics courses completed in high school

	Marginally or not qualified	Minimally to somewhat qualified	Very qualified	Highly qualified
Total	32.4	32.9	19.5	15.2
Mathematics course level completed				
No mathematics, low or nonacademic	85.6	12.6	1.8	0.0
Middle academic I (algebra 1 and geometry)	63.8	32.0	3.7	0.4
Middle academic II (algebra 2)	22.1	53.3	18.6	5.9
Advanced academic (beyond algebra 2)[2]	4.7	26.2	34.5	34.6
		First-generation		
Total	49.2	32.3	11.6	6.9
Mathematics course level completed				
No mathematics, low or nonacademic	87.9	10.6	1.5	0.0
Middle academic I (algebra 1 and geometry)	69.7	27.8	1.6	1.0
Middle academic II (algebra 2)	26.5	54.6	13.3	5.7
Advanced academic (beyond algebra 2)[2]	7.6	34.8	33.9	23.7
		Parents have some college		
Total	32.7	36.4	18.9	12.0
Mathematics course level completed				
No mathematics, low or nonacademic	86.1	11.4	2.5	0.0
Middle academic I (algebra 1 and geometry)	59.9	36.2	3.7	0.2
Middle academic II (algebra 2)	23.3	52.0	20.1	4.5
Advanced academic (beyond algebra 2)[2]	4.8	32.3	33.4	29.4
		Parents have bachelor's or advanced degree		
Total	15.3	28.5	28.4	27.9
Mathematics course level completed				
No mathematics, low or nonacademic	68.3	29.6	2.1	0.0
Middle academic I (algebra 1 and geometry)	59.9	32.3	7.3	0.4
Middle academic II (algebra 2)	16.1	52.0	23.8	8.1
Advanced academic (beyond algebra 2)[2]	3.2	18.9	35.7	42.2

[1]Based on an index of five measures including high school GPA, rank in class, NELS 1992 aptitude test, and SAT and ACT test scores among NELS 1992 high school graduates who enrolled in a 4-year college. "Marginally or not qualified"—no value on any criterion that placed them in the top 75 percent of 4-year college students; "Minimally to somewhat qualified"—had at least one value that placed them either in the top 75 or 50 percent of 4-year college students; "very qualified"—had at least one value that placed them in the top 25 percent of 4-year college students; "highly qualified"—had at least one value that placed them in the top 10 percent of 4-year college students.

[2]Completed at least one class beyond algebra 2 labeled "advanced" including precalculus, calculus, trigonometry, probability, statistics, algebra 3, etc.

NOTE: Details may not sum to 100 due to rounding.

SOURCE: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study: 1988–94 (NELS:88), Data Analysis System.

Table 8—Percentage of 1992 high school graduates enrolled in postsecondary education by 1994, by first-generation status and the highest level of mathematics courses completed in high school

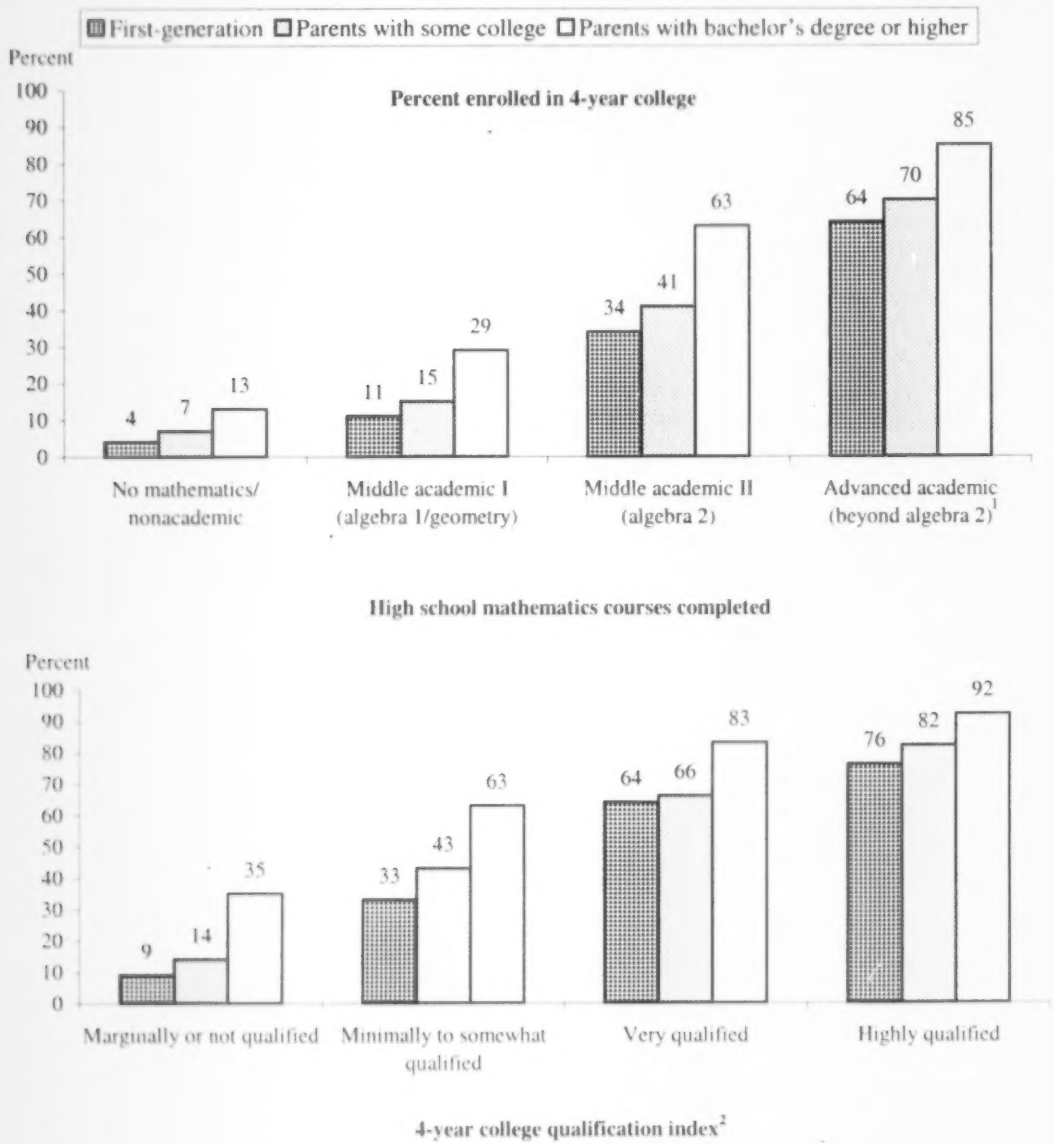
	Did not enroll by 1994	Enrolled in postsecondary education			
		Total	4-year	Public 2-year	Other[1]
Total	24.4	75.6	45.9	25.6	4.2
Mathematics course level completed					
No mathematics, low or nonacademic	58.4	41.6	6.1	28.1	7.3
Middle academic I (algebra 1 and geometry)	42.3	57.7	15.7	35.4	6.7
Middle academic II (algebra 2)	20.4	79.6	43.9	31.4	4.2
Advanced academic (beyond algebra 2)[2]	6.6	93.4	76.0	15.5	1.9
First-generation					
Total	41.6	58.4	26.9	25.9	5.6
Mathematics course level completed					
No mathematics, low or nonacademic	64.9	35.1	4.4	24.1	6.6
Middle academic I (algebra 1 and geometry)	53.4	46.6	10.8	29.3	6.5
Middle academic II (algebra 2)	31.1	68.9	33.7	29.9	5.2
Advanced academic (beyond algebra 2)[2]	14.3	85.7	63.7	18.4	3.6
Parents have some college					
Total	23.8	76.2	41.6	30.5	4.2
Mathematics course level completed					
No mathematics, low or nonacademic	54.1	45.9	7.3	34.3	4.4
Middle academic I (algebra 1 and geometry)	38.1	61.9	15.3	39.6	7.1
Middle academic II (algebra 2)	20.4	79.6	40.7	34.2	4.7
Advanced academic (beyond algebra 2)[2]	7.9	92.1	69.7	20.6	1.8
Parents have bachelor's or advanced degree					
Total	7.7	92.3	70.8	18.4	3.1
Mathematics course level completed					
No mathematics, low or nonacademic	38.9	61.1	12.8	29.9	18.3
Middle academic I (algebra 1 and geometry)	24.6	75.4	28.5	41.2	5.8
Middle academic II (algebra 2)	8.3	91.7	62.7	25.4	3.6
Advanced academic (beyond algebra 2)[2]	2.5	97.5	85.1	10.9	1.5

[1]Includes private, for-profit institutions and other less-than-4-year institutions.

[2]Completed at least one class beyond algebra 2 labeled "advanced" including precalculus, calculus, trigonometry, probability, statistics, algebra 3, etc.

SOURCE: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study: 1988–94 (NELS:88/94), Data Analysis System.

Figure 7—Percentage of 1992 high school graduates who enrolled in a 4-year college by 1994, by high school mathematics level, college qualification index, and first-generation status



[1]Completed at least one class beyond algebra 2 labeled "advanced" including precalculus, calculus, trigonometry, probability, statistics, algebra 3, etc.

[2]Based on an index of five measures including high school GPA, rank in class, NELS 1992 aptitude test, and SAT and ACT test scores among NELS 1992 high school graduates who enrolled in a 4-year college. "Marginally or not qualified"—no value on any criterion that placed them in the top 75 percent of 4-year college students; "Minimally to somewhat qualified"—had at least one value that placed them either in the top 75 or 50 percent of 4-year college students; "very qualified"—had at least one value that placed them in the top 25 percent of 4-year college students; "highly qualified"—had at least one value that placed them in the top 10 percent of 4-year college students.

SOURCE: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study: 1988–94 (NELS:88/94), Data Analysis System.

had attended some college had enrolled in a 4-year college. In other words, a majority of students whose parents were college graduates and who had completed mathematics courses through algebra 2, but had taken no advanced classes, had enrolled in 4-year colleges, compared with about one-third of first-generation and less than one-half of students whose parents had attended some college. Among students who completed any advanced mathematics courses, first-generation students and students whose parents had attended some college were also less likely to enroll in a 4-year college (64 and 70 percent versus 85 percent).

Even being highly qualified for admission to a 4-year college did not necessarily lead to enrollment for some first-generation students (figure 7). While nearly all highly qualified students whose parents had at least a bachelor's degree enrolled in a 4-year college (92 percent), roughly three-quarters (76 percent) of first-generation students did the same. Furthermore, 13 percent of highly qualified first-generation students had not enrolled in any postsecondary education within two years of high school graduation, compared with 1 percent of their counterparts whose parents were college graduates (table 9). It is also notable that among marginally or unqualified students, roughly one-third (35 percent) of those whose parents were college graduates had enrolled in a 4-year college, compared with 9 percent of comparable first-generation students.

In summary, this analysis indicated that first-generation students consistently trailed their counterparts whose parents were college graduates—and to some extent those whose parents had some college but less than a bachelor's degree--in participating in mathematics curricula leading to college enrollment. This was often the case even among the most academically promising first-generation students. That is, they were less likely to take algebra in the eighth grade and less likely to complete advanced high school mathematics courses, even if they took algebra in the eighth grade. Correspondingly, even highly qualified first-generation students with academic credentials similar to students whose parents were college graduates enrolled in 4-year colleges at lower rates than their counterparts. At the same time, it is important to note that first-generation students who took algebra in the eighth grade were more than twice as likely to complete advanced-level mathematics coursework in high school (figure 8). And, in turn, those who completed any advanced-level mathematics courses in high school more than doubled their chances of enrolling in a 4-year college.

Table 9—Percentage of 1992 high school graduates who enrolled in postsecondary education by 1994, by first-generation status and their score on the college qualification index

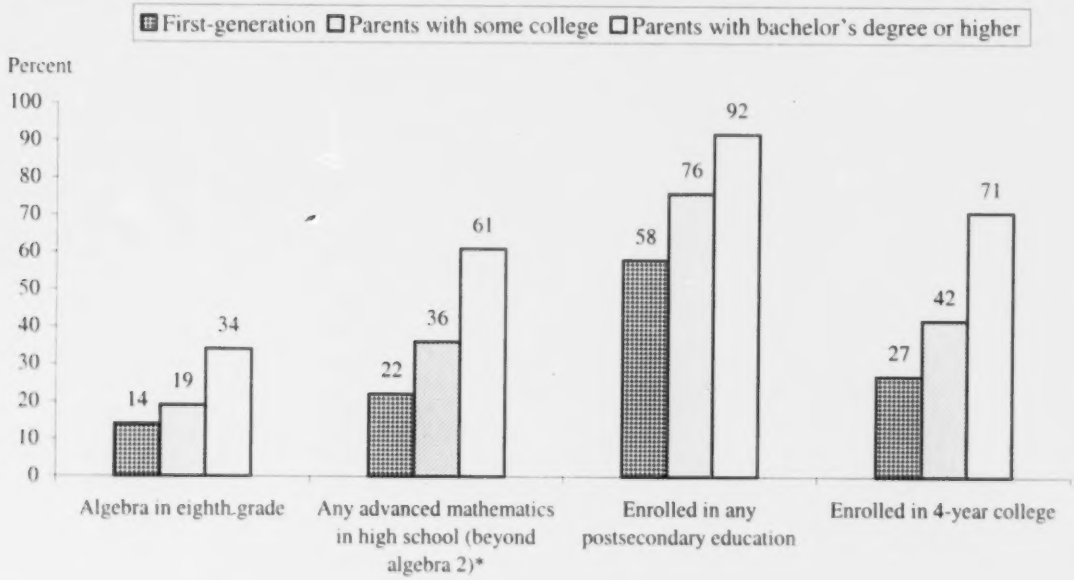
	Did not enroll by 1994	Enrolled in postsecondary education			
		Total	4-year	Public 2-year	Other[1]
Total	24.8	75.2	45.9	25.7	4.4
College qualification index[2]					
Marginally or not qualified	47.9	52.1	14.7	30.3	7.0
Minimally to somewhat qualified	19.5	80.5	45.1	31.1	4.3
Very qualified	6.3	93.7	72.6	18.9	2.2
Highly qualified	3.9	96.1	86.9	8.3	0.9
First-generation					
Total	41.0	59.0	26.9	27.3	5.8
College qualification index[2]					
Marginally or not qualified	58.8	41.2	8.6	25.1	7.5
Minimally to somewhat qualified	29.9	70.1	32.7	32.6	4.8
Very qualified	10.1	89.9	64.3	21.3	4.3
Highly qualified	13.3	86.7	75.6	10.6	0.6
Parents have some college					
Total	25.3	74.7	41.6	29.5	4.2
College qualification index[2]					
Marginally or not qualified	44.5	55.5	13.5	35.3	6.7
Minimally to somewhat qualified	19.6	80.4	43.2	33.3	3.9
Very qualified	8.7	91.3	65.8	23.4	2.1
Highly qualified	5.2	94.8	81.6	12.2	1.0
Parents have bachelor's or advanced degree					
Total	7.5	92.5	70.8	18.0	3.1
College qualification index[2]					
Marginally or not qualified	23.1	76.9	34.8	36.3	5.9
Minimally to somewhat qualified	7.8	92.2	63.2	24.1	4.9
Very qualified	2.7	97.3	83.3	12.6	1.4
Highly qualified	1.4	98.6	92.0	5.7	0.9

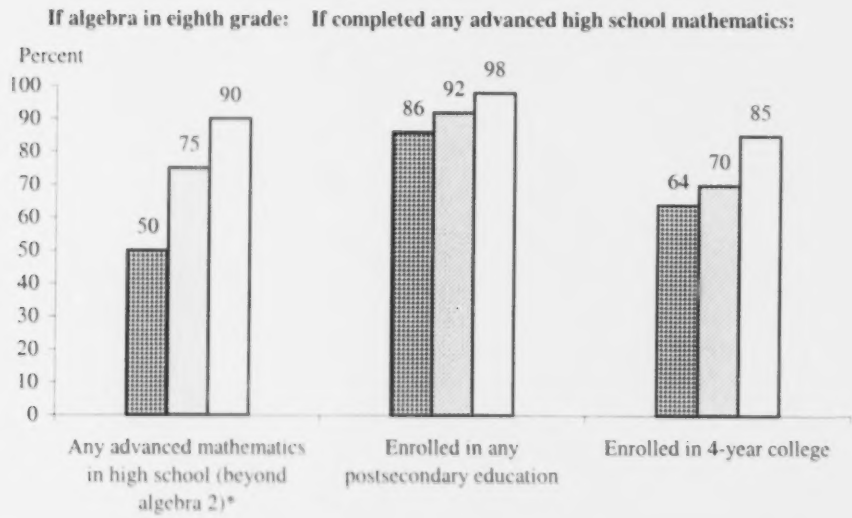
[1]Includes private, for-profit institutions and other less-than-4-year institutions.

[2]Based on an index of five measures including high school GPA, rank in class, NELS 1992 aptitude test, and SAT and ACT test scores among NELS 1992 high school graduates who enrolled in a 4-year college. "Marginally or not qualified"—no value on any criterion that placed them in the top 75 percent of 4-year college students; "Minimally to somewhat qualified"—had at least one value that placed them either in the top 75 or 50 percent of 4-year college students; "very qualified"—had at least one value that placed them in the top 25 percent of 4-year college students; "highly qualified"—had at least one value that placed them in the top 10 percent of 4-year college students.

SOURCE: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study: 1988–94 (NELS:88), Data Analysis System.

Figure 8—Percentage of 1992 high school graduates with respect to mathematics curricula and enrollment in postsecondary education, by first-generation status





[1]Completed at least one class beyond algebra 2 labeled "advanced" including precalculus, calculus, trigonometry, probability, statistics, algebra 3, etc.

SOURCE: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study: 1988–94 (NELS:88/94), Data Analysis System.

Curricular Choices

Why does parents' education make such a difference with respect to participation in curricula leading to college enrollment even for students with comparable academic ability? Prior research has suggested the influence of a variety of school- and parent-related factors on these outcomes. At the school level, opportunities for students to take higher level curricular offerings (Oakes 1990) and the extent of access to guidance counseling, vary according to the academic track in which the student is enrolled (Lee and Ekstrom 1987). These studies imply that students from lower socioeconomic (SES) and first-generation backgrounds are more likely to be tracked into lower level classes and, therefore, have less access to the counseling that might guide them into higher level classes. The findings discussed in the preceding analysis showed that first-generation students were less likely to take and/or had less access to high school algebra in the eighth grade. First-generation students were also more likely than others to attend public schools and to attend schools in rural areas, which may have fewer course offerings and resources than private schools or schools in suburban areas.

Regardless of the type of school students attend, however, parents can influence their children's curriculum by sharing knowledge about courses and communicating directly with school personnel about their children's placement in particular curricular pathways. Research has shown that the intensity and specific type of parental involvement influence the academic placement of students and that strategies for overseeing their children's education vary according to parental education level, even when parental aspirations are similar (Baker and Stevenson 1986; Useem 1992). These studies suggest that because lower SES and first-generation students may have access to fewer sources of information and their parents may be less aware of the importance of taking particular courses, these students may need more counseling about course taking and college than other students. In other words, they may depend more on "institutional agents" within the school, such as teachers, guidance counselors, and principals, to provide them with guidance in academic planning (Stanton-Salazar 1997). To further understand why students whose parents have less education are less likely to enroll in higher level mathematics, and later in college, this section examines how different school and family agents are involved in guiding the student toward selecting courses and applying to college.

Who Encouraged Taking Algebra in the Eighth Grade?

As illustrated in table 10, the likelihood that 1992 high school graduates reported that their parents encouraged them to take algebra in the eighth grade increased with parents' education levels, from 31 percent of first-generation students, to 39 percent of students whose parents had some college, to 53 percent of students whose parents were college graduates. This remained true when controlling for mathematics proficiency in the eighth grade. For example, among students who were proficient at the highest level tested, first-generation students (52 percent) and those whose parents had some college (59 percent) were also less likely than those whose parents had bachelor's degrees (70 percent) to indicate that their parents had encouraged them to take algebra.

Teachers and counselors can also play an important role in raising students' awareness of the courses that will best prepare them for college. Yet overall, first-generation students (35 percent) and students whose parents had some college (37 percent) were less likely than those whose parents had bachelor's degrees (43 percent) to indicate that a teacher or counselor had encouraged them to take algebra in the eighth grade. However, being encouraged by a teacher or counselor varied with mathematics proficiency, not with parents' education level. Regardless of parents' education, students who scored at any level below level 3 were less likely than those proficient at level 3 to indicate that a teacher or counselor had encouraged them to take eighth-grade algebra.[8]

There were modest differences with respect to the role that principals and friends played in students' decision to take eighth-grade mathematics. Encouragement by these individuals, however, varied with students' mathematics proficiency, and very little with parents' education. For example, among first-generation students, 16 percent who tested below level 1 proficiency reported being encouraged to take algebra by the principal, compared with 29 percent who were proficient at level 3. There were no apparent differences according to parental education level or eighth-grade mathematics proficiency with respect to whether or not students were encouraged by their friends to take algebra in the eighth grade.

Academic Planning for High School

As eighth graders, 1992 high school graduates were asked to report with whom and how often they discussed planning their high school program. As shown in table 11, students frequently discussed their high school plans with their mothers (3 or more times) more often than

[8]There was one exception: the difference between level 3 and level 2 proficiency for first-generation students was significant at the 0.1 level.

Table 10—Percentage of 1992 high school graduates who reported that various people encouraged them to take algebra in the eighth grade, by first-generation status and eighth-grade mathematics proficiency

	Parents[1]	Teacher or counselor[2]	Principal[3]	Friends[4]
Total	41.0	38.1	21.7	15.7
Mathematics proficiency in 1988[5]				
Below level 1	26.6	33.5	16.7	16.0
Level 1	31.2	31.6	16.7	14.0
Level 2	41.6	36.6	21.3	14.5
Level 3	63.7	51.0	32.2	18.9
First-generation				
Total	30.6	35.0	20.6	15.5
Below level 1	22.4	29.4	15.9	14.0
Level 1	27.2	33.5	18.8	15.0
Level 2	33.6	35.3	22.3	14.6
Level 3	51.6	47.3	29.2	17.2
Parents have some college				
Total	39.3	37.1	21.3	15.7
Below level 1	26.4	32.8	16.3	16.5
Level 1	33.1	32.5	17.6	14.7
Level 2	41.5	36.6	22.4	14.7
Level 3	58.9	49.0	32.5	18.9
Parents have bachelor's or advanced degree				
Total	53.0	43.2	23.7	15.8
Below level 1	34.6	32.8	14.5	14.3
Level 1	36.8	32.4	15.9	11.2
Level 2	47.5	38.0	19.5	14.1
Level 3	69.5	53.6	32.4	19.2

[1]Parents wanted student to take algebra.

[2]Student talked to teacher or counselor about taking algebra.

[3]Student was asked to take algebra by principal.

[4]Student was encouraged by friends to take algebra.

[5]Level 1: Can perform simple arithmetical operations on whole numbers. Level 2: Can perform simple operations with decimals, fractions, roots. Level 3: Can perform simple problem solving requiring conceptual understanding or the devlopment of a solution strategy.

SOURCE: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study: 1988–94 (NELS:88), Data Analysis System.

Table 11—Percentage of 1992 high school graduates who reported that they consulted with various people frequently (three or more times) about their high school program when they were eighth graders, by first-generation status and eighth-grade mathematics proficiency

	Mother	Father	Counselor	Teachers	Relatives	Friends
Total	59.6	43.0	15.6	15.8	29.7	51.2
Mathematics proficiency in 1988*						
Below level 1	55.1	42.2	13.7	16.8	33.1	50.6
Level 1	57.3	39.9	15.2	16.4	29.8	48.4
Level 2	61.4	42.2	15.3	13.2	29.3	51.9
Level 3	62.9	47.0	16.3	16.6	27.0	56.0
First-generation						
Total	57.6	34.1	17.5	20.5	33.8	49.2
Below level 1	52.1	37.4	16.6	22.2	35.1	51.6
Level 1	56.9	32.4	17.0	21.5	35.7	47.7
Level 2	62.6	33.7	17.4	15.5	31.5	52.1
Level 3	59.6	31.8	16.0	21.1	28.4	53.4
Parents have some college						
Total	59.6	40.9	13.9	13.1	29.3	51.9
Below level 1	56.8	39.8	16.4	13.2	32.7	50.8
Level 1	57.9	40.6	11.9	13.1	28.2	49.3
Level 2	60.0	39.1	12.8	11.0	28.0	53.8
Level 3	61.6	43.1	14.1	13.7	27.8	54.9
Parents have bachelor's or advanced degree						
Total	62.4	50.2	15.4	15.1	26.3	51.7
Below level 1	58.0	55.9	8.6	8.8	28.0	48.6
Level 1	61.0	47.8	14.1	15.2	27.6	50.2
Level 2	64.3	49.9	17.9	15.3	27.3	48.3
Level 3	63.3	50.6	16.1	15.6	24.4	55.3

*Level 1: Can perform simple arithmetical operations on whole numbers. Level 2: Can perform simple operations with decimals, fractions, roots. Level 3: Can perform simple problem solving requiring conceptual understanding or the development of a solution strategy.

SOURCE: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study: 1988–94 (NELS:88), Data Analysis System.

with anyone else. However, such discussions varied little with parents' education.[9] In contrast, the likelihood that students frequently discussed their high school program with their fathers increased with parents' education levels: 34 percent of first-generation students, 41 percent of students whose parents had some college, and 50 percent of students whose parents were college graduates reported frequent discussions with their fathers. This pattern held even among students who were proficient at the highest mathematics level tested when comparing first-generation students to students whose parents were college graduates (32 versus 51 percent).

The differences in counselor or teacher interaction, however, were less apparent. There was a slight difference between first-generation students and students whose parents had bachelor's degrees in whether they reported talking to their teachers about planning their high school program (21 versus 15 percent). First-generation students also appeared to be more likely to have talked to teachers than did students whose parents had some college (21 versus 13 percent), but there was not enough statistical evidence to conclude that the two groups differed in this respect.

There was some indication that first-generation students consulted with individuals other than school staff or immediate family about selecting their high school program more often than their counterparts whose parents had more education. For instance, they were more likely than students whose parents had college degrees to have discussed their high school programs with their close relatives three or more times (34 versus 26 percent). This may be related to the finding that first-generation students were more likely to live in single-parent homes and, therefore, might have been looking to familial figures other than parents for guidance. Further evidence of this is supported by the finding that first-generation students were more likely to report consulting with their friends than with their fathers (49 versus 34 percent) about their high school programs.[10] The same was not true for students whose parents were college graduates, among whom 50 percent reported frequent discussions with fathers and 52 percent reported such discussions with friends.

The pattern of parental involvement highlighted in the eighth grade was also apparent when, as seniors in high school, students reported the persons who played an important role in helping them select their high school academic program (table 12). Overall, as parents' education increased, the likelihood that students reported being helped by their parents in choosing their high school program also increased, from 34 percent of first-generation students, to 39 percent of students whose parents had some college, to 48 percent of students whose parents had

[9]There was a slightly significant difference between first-generation students and those whose parents were college graduates (58 versus 62 percent).

[10]Students whose parents had some college and who tested at level 3 mathematics proficiency were also more likely to talk to friends than to fathers (55 versus 43 percent).

Table 12—Percentage of 1992 high school graduates who reported (in the twelfth grade) choosing their high school program with various people, by first-generation status and eighth-grade mathematics proficiency

	Was assigned high school program	Chose high school program with teacher or counselor	Chose high school program with parents	Chose high school program with friends	Chose high school program alone	Only one high school program available
Total	32.8	42.9	40.0	23.5	25.9	13.0
Mathematics proficiency in 1988*						
Below level 1	37.2	39.5	34.1	21.2	26.2	12.7
Level 1	33.8	42.3	37.6	21.3	27.0	10.9
Level 2	32.1	43.6	40.8	23.6	25.6	13.1
Level 3	27.8	44.9	49.2	29.2	25.2	16.4
First-generation						
Total	33.7	42.9	34.0	22.5	28.0	10.8
Below level 1	42.2	38.5	32.5	22.0	25.6	12.1
Level 1	31.1	40.8	34.6	21.1	27.4	9.9
Level 2	31.0	45.3	36.4	23.5	31.6	7.3
Level 3	23.3	48.6	41.2	31.7	31.0	12.1
Parents have some college						
Total	32.7	42.8	38.8	23.0	26.5	10.8
Below level 1	35.0	42.3	35.7	20.3	25.6	10.2
Level 1	34.0	41.7	37.7	21.4	27.1	10.8
Level 2	31.9	45.6	36.6	25.2	25.3	11.9
Level 3	27.4	43.0	47.6	27.6	27.9	12.1
Parents have bachelor's or advanced degree						
Total	31.3	43.1	48.2	25.5	21.9	18.4
Below level 1	28.4	31.2	37.7	18.9	26.4	18.0
Level 1	36.8	48.0	45.8	23.9	20.3	13.8
Level 2	32.5	39.1	47.9	22.2	22.1	19.0
Level 3	28.4	44.3	52.3	29.6	21.9	20.4

*Level 1: Can perform simple arithmetical operations on whole numbers. Level 2: Can perform simple operations with decimals, fractions, roots. Level 3: Can perform simple problem solving requiring conceptual understanding or the devlopment of a solution strategy.

SOURCE: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study: 1988–94 (NELS:88), Data Analysis System.

bachelor's degrees. At the same time, there were no apparent differences across parent education levels or eighth-grade mathematics proficiency in whether or not students reported that teachers, counselors, or friends helped them choose their high school programs.

There was some indication that first-generation students were more likely than students whose parents had college degrees to report that they chose their high school programs alone. For instance, among students who were proficient at the highest level of mathematics tested in the eighth grade, 31 percent of first-generation students and 22 percent of students whose parents were college graduates reported choosing their high school programs alone.[11] Finally, the results also revealed that among students who had difficulty with mathematics in the eighth grade (scored below level 1), first-generation students were more likely than students whose parents had college degrees (42 versus 28 percent) to report that they were assigned their high school programs.

Senior-Year Mathematics Course

While students did not report specifically on how they chose their high school mathematics curricula, they did report whether or not they were taking a mathematics course in their senior year and who played an important role in helping them choose the course. Taking mathematics in twelfth grade may be an indication of taking advanced-level courses. In the analysis, students were divided into two groups: those who completed courses through middle academic level II (through algebra 2) or above, and those who completed courses below middle academic level II.

Consistent with the findings in this report regarding the level of high school mathematics program students completed, the likelihood that students reporting taking a mathematics class in their senior year varied with parents' education, even when controlling for mathematics program level (table 13). That is, as parents' education increased, so did the likelihood that students reported taking a mathematics class in their senior year. This pattern held even among students completing algebra 2 or higher courses: first-generation students and those whose parents had some college were less likely than students whose parents were college graduates to take mathematics in their senior year (63 and 68 percent versus 75 percent).

Students who indicated taking a mathematics class in their senior year also reported on the importance of certain individuals in helping them choose the class. Among these students, as parents' education increased, so did students' likelihood of reporting that their parents played a very or somewhat important role in helping them choose their senior-year mathematics course

[11] Significant at the 0.1 level.

Table 13—Percentage of 1992 high school graduates who took mathematics in their senior year, and among those who took mathematics, the percentage who reported that certain individuals played a very or somewhat important role in helping them choose which mathematics course to take, by first-generation status and the highest level of mathematics courses completed in high school

	Took mathematics in 12th grade	If took mathematics, who helped choose class:			
		Parents	Teacher	Counselor	Friends
Total	63.3	64.5	58.1	58.9	39.5
Highest level mathematics course taken					
Below middle academic II[1]	48.2	59.2	51.2	68.1	34.5
Middle academic II or above[2]	69.6	67.0	60.6	56.2	41.5
First-generation					
Total	56.0	54.6	54.7	64.8	37.0
Highest level mathematics course taken					
Below middle academic II[1]	46.2	54.7	51.1	70.7	33.9
Middle academic II or above[2]	63.3	55.8	56.8	60.7	38.9
Parents have some college					
Total	62.0	63.6	57.2	59.1	38.5
Highest level mathematics course taken					
Below middle academic II[1]	50.5	61.0	50.2	70.0	34.0
Middle academic II or above[2]	67.9	65.7	60.4	54.6	42.2
Parents have bachelor's or advanced degree					
Total	70.6	73.4	61.1	55.8	40.8
Highest level mathematics course taken					
Below middle academic II[1]	48.0	66.9	53.2	61.2	32.3
Middle academic II or above[2]	74.5	74.0	61.7	54.9	41.2

[1]Completed courses no higher than algebra 1 and geometry.

[2]Completed courses through algebra 2 or higher.

SOURCE: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study: 1988–94 (NELS:88), Data Analysis System.

(55 percent of first-generation students, 64 percent of students whose parents had some college, and 73 percent of students whose parents were college graduates). These differences, however, were observed only for students in higher level mathematics programs (took algebra 2 or higher classes). Among students in lower level mathematics programs (took classes lower than algebra 2), no measurable differences were found in the percentages of students who reported that their parents played a very or somewhat important role in choosing their mathematics course.

For first-generation students, counselors appeared to play a more important role than parents and others in helping them decide which mathematics course to take in their senior year. About two-thirds (65 percent) reported that their counselors played an important role, compared with 37 to 55 percent who reported that others were important in helping them decide. In contrast, students whose parents were college graduates were most likely to say that their parents played an important role in helping them decide which mathematics course to take (73 versus 61 percent for teacher, 56 percent for counselor, and 41 percent for friends).

Overall, as with selecting their high school program, no apparent differences were observed in relation to either level of parents' education or students' mathematics course taking in whether or not students indicated that their teacher or friends played a very or somewhat important role in helping them choose their senior-year mathematics course.

Planning for and Applying to College

This report has shown that first-generation students enroll in postsecondary education at lower rates than their non-first-generation counterparts, even when controlling for mathematics ability and qualification for college admission. Why is this the case? A review of the research in this area suggests that parental education level, when compared with other important background characteristics such as race or gender, has the strongest influence on how students select colleges (Litten 1982). This next section of the report compares first-generation students and others with respect to how and from whom they obtained information about important steps in applying to and enrolling in college.

College Entrance Exams

Taking the SAT or ACT is a necessary step in applying to most 4-year colleges. In the NELS survey, students were asked in the tenth grade how often they discussed preparing for college entrance exams with their parents. Among college-qualified students,[12] first-generation students and those whose parents had some college more often reported they *never* had such a discussion than students whose parents had college degrees (table 14). Roughly half (55 and 51 percent, respectively) of these students reported having no discussions about college entrance exams, compared with 35 percent of students whose parents were college graduates. Conversely, among college-qualified students, those whose parents had college degrees were more likely than others who were similarly qualified to report that they *often* discussed entrance exam preparation with their parents (15 percent versus 7 percent of first-generation students and 9 percent of students whose parents had some college).

When they reached the twelfth grade, the likelihood of students reporting that they never discussed entrance exam preparation with their parents declined, especially among college-qualified students (from 46 to 25 percent). However, the frequency of such discussions still varied with parents' education. For example, among college-qualified students, about one-third of first-generation students reported that they never discussed entrance exam preparation with their parents, compared with one-quarter of students whose parents had some college and one-fifth of students whose parents had college degrees. Correspondingly, among college-qualified students,

[12]Those students who were in the top 75 percent of students who enrolled in a 4-year college based on at least one of five criteria variables (see appendix A under "CQCOMV2" entry for detailed definition).

Table 14—Percentage distribution of 1992 high school graduates with respect to how frequently they discussed SAT/ACT preparation with parents, as reported in tenth and twelfth grades, by first-generation status, 4-year college qualification index, and 4-year institution enrollment status

	Tenth grade			Twelfth grade		
	Never	Sometimes	Often	Never	Sometimes	Often
Total	50.5	39.7	9.8	31.2	49.9	18.9
College qualified*						
Yes	45.6	44.0	10.4	24.6	53.3	22.1
No	59.9	32.6	7.5	44.7	42.7	12.6
If college qualified						
Enrolled in 4-year institution	39.6	47.4	13.0	19.2	54.4	26.3
Enrolled in less-than-4-year institution	54.9	38.6	6.5	32.9	51.6	15.5
First-generation						
Total	58.9	34.0	7.1	42.9	44.0	13.1
College qualified*						
Yes	55.3	37.8	6.9	33.1	50.8	16.2
No	62.3	30.6	7.1	52.3	37.9	9.8
If college qualified						
Enrolled in 4-year institution	49.4	41.6	9.0	23.7	56.6	19.8
Enrolled in less-than-4-year institution	60.2	34.7	5.1	40.9	45.9	13.2
Parents have some college						
Total	54.1	37.9	8.0	31.0	51.0	18.1
College qualified*						
Yes	51.3	40.2	8.5	24.7	54.9	20.4
No	59.7	33.4	7.0	42.9	43.1	14.0
If college qualified						
Enrolled in 4-year institution	44.9	44.0	11.1	18.3	56.3	25.4
Enrolled in less-than-4-year institution	59.0	35.7	5.3	32.1	53.4	14.5
Parents have bachelor's or advanced degree						
Total	37.7	48.0	14.3	21.5	53.1	25.3
College qualified*						
Yes	35.3	50.2	14.5	19.6	53.3	27.1
No	50.5	38.7	10.8	29.2	53.9	16.9
If college qualified						
Enrolled in 4-year institution	33.1	51.0	15.9	18.4	52.5	29.1
Enrolled in less-than-4-year institution	42.5	47.6	9.9	23.7	55.9	20.4

*Had at least one value on index (high school GPA, rank in class, SAT and ACT test scores, NELS 1992 aptitude test) that placed them in the top 75 percent of 4-year college students.

NOTE: Details may not sum to 100 due to rounding.

SOURCE: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study: 1988–94 (NELS:88), Data Analysis System.

first-generation students were less likely than students whose parents had bachelor's degrees to indicate that they *often* discussed SAT or ACT preparation with their parents (16 versus 20 percent and 27 percent, respectively). In other words, among college-qualified students in both tenth and twelfth grades, first-generation students reported having discussions with their parents about preparing for entrance exams less often than their counterparts whose parents graduated from college.

Planning for College With Parents

As was true for discussing entrance exam preparation, in both tenth and twelfth grades, as parental education level increased, the likelihood that college-qualified students reported that they *never* discussed applying to college with their parents declined (table 15). Conversely, among college-qualified students, those whose parents were college graduates were more likely than other college-qualified students to say that they *often* discussed postsecondary education plans with their parents (49 versus 41 percent for both first-generation students and students whose parents had some college).

When asked again in the twelfth grade, differences across parents' education level were still apparent among college-qualified students. A majority (61 percent) of students whose parents were college graduates indicated that they *often* discussed applying to college with their parents, compared with 47 percent of those whose parents had some college and 42 percent of first-generation students.

What Parents Report

How often parents reported participating in obtaining information about educational opportunities, specific colleges, and financial aid availability varied with their education level (tables 16 and 17). For example, among parents of college-qualified students, as their education level increased, so did the likelihood that parents reported attending a program on educational opportunities for their children. About 29 percent of the parents of college-qualified first-generation students indicated that they had engaged in this activity, compared with 39 percent of students whose parents attended some college and 51 percent of parents with bachelor's degrees (table 16). Parents of college-qualified first-generation students were also less likely than other parents of similarly qualified students to indicate that they had attended a program about financial aid (39 percent of parents of first-generation students versus 46 percent of parents with some college and 48 percent of parents with college degrees). Even controlling for 4-year college enrollment, differences by parents' education emerged.

Table 15—Percentage distribution of 1992 high school graduates with respect to how frequently they discussed postsecondary plans with parents, as reported by students in tenth and twelfth grades, by first-generation status, 4-year college qualification index, and 4-year institution enrollment status

	Tenth grade			Twelfth grade		
	Never	Sometimes	Often	Never	Sometimes	Often
Total	10.7	48.6	40.7	13.2	43.8	43.0
College qualified*						
Yes	6.2	48.9	44.9	7.1	42.2	50.7
No	19.1	49.0	32.0	25.9	47.6	26.5
If college qualified						
Enrolled in 4-year institution	3.7	47.5	48.9	2.7	35.4	61.9
Enrolled in less-than-4-year institution	10.1	51.1	38.9	13.9	52.8	33.3
First-generation						
Total	18.5	47.4	34.1	22.4	47.0	30.6
College qualified*						
Yes	10.1	48.6	41.3	11.7	46.3	42.0
No	25.0	46.4	28.5	32.5	47.2	20.2
If college qualified						
Enrolled in 4-year institution	4.5	49.3	46.2	5.1	38.4	56.5
Enrolled in less-than-4-year institution	14.7	48.0	37.3	17.1	52.9	30.0
Parents have some college						
Total	9.7	51.1	39.2	13.2	44.6	42.1
College qualified*						
Yes	6.0	52.7	41.3	8.4	44.5	47.1
No	16.3	49.3	34.4	23.6	46.6	29.8
If college qualified						
Enrolled in 4-year institution	3.7	49.9	46.4	3.0	38.6	58.5
Enrolled in less-than-4-year institution	8.7	56.1	35.2	14.7	51.6	33.7
Parents have bachelor's or advanced degree						
Total	4.0	48.5	47.5	5.0	38.8	56.2
College qualified*						
Yes	3.4	47.8	48.8	2.8	36.6	60.6
No	8.4	53.1	38.4	14.3	48.1	37.6
If college qualified						
Enrolled in 4-year institution	2.8	47.0	50.2	1.7	31.8	66.5
Enrolled in less-than-4-year institution	5.3	50.5	44.1	6.5	52.7	40.7

*Had at least one value on index (high school GPA, rank in class, SAT and ACT test scores, NELS 1992 aptitude test) that placed them in the top 75 percent of 4-year college students.

NOTE: Details may not sum to 100 due to rounding.

SOURCE: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study: 1988–94 (NELS:88), Data Analysis System.

Table 16—Percentage of 1992 high school graduates whose parents reported attending college information-gathering activities, by first-generation status, 4-year college qualification index, and 4-year institution enrollment status

	Parents' involvement in programs		
	Attended program about educational opportunities	Attended program about postsecondary education financial aid	Attended program about work opportunities
Total	35.2	37.8	15.0
College qualified*			
Yes	41.9	45.5	14.7
No	22.1	23.0	13.8
If college qualified			
Enrolled in 4-year institution	48.8	53.3	15.1
Enrolled in less-than-4-year institution	30.8	32.9	14.0
First-generation			
Total	21.4	27.5	12.9
College qualified*			
Yes	28.9	39.1	14.3
No	15.5	18.3	11.8
If college qualified			
Enrolled in 4-year institution	36.9	50.2	13.4
Enrolled in less-than-4-year institution	22.4	30.2	15.0
Parents have some college			
Total	33.0	38.5	15.9
College qualified*			
Yes	38.6	45.9	14.7
No	22.5	24.5	15.4
If college qualified			
Enrolled in 4-year institution	44.2	56.0	15.5
Enrolled in less-than-4-year institution	31.9	33.8	13.7
Parents have bachelor's or advanced degree			
Total	48.6	45.0	15.3
College qualified*			
Yes	50.7	47.8	14.8
No	35.7	30.1	14.3
If college qualified			
Enrolled in 4-year institution	54.9	52.2	15.2
Enrolled in less-than-4-year institution	37.5	33.8	13.3

*Had at least one value on index (high school GPA, rank in class, SAT and ACT test scores, NELS 1992 aptitude test) that placed them in the top 75 percent of 4-year college students.

SOURCE: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study: 1988–94 (NELS:88), Data Analysis System.

Table 17—Percentage of 1992 high school graduates whose parents reported that they participated in preparing for their child's postsecondary education, by first-generation status, 4-year college qualification index, and 4-year institution enrollment status

	Visited postsecondary institution at least once	Sought financial aid information	Talked about aid with guidance counselor	Talked about aid with college representative
Total	71.3	75.6	52.8	57.0
College qualified*				
Yes	74.2	80.7	55.1	57.3
No	61.9	63.9	47.7	56.9
If college qualified				
Enrolled in 4-year institution	80.6	85.9	59.2	60.9
Enrolled in less-than-4-year institution	60.6	72.0	46.6	50.0
		First-generation		
Total	58.2	63.8	50.6	51.0
College qualified*				
Yes	61.0	71.6	51.3	52.6
No	53.2	55.2	51.6	49.8
If college qualified				
Enrolled in 4-year institution	67.1	81.9	57.6	57.1
Enrolled in less-than-4-year institution	54.1	62.6	44.0	47.3
		Parents have some college		
Total	69.4	78.2	52.3	60.2
College qualified*				
Yes	70.9	82.6	55.2	59.6
No	63.5	67.8	45.8	60.7
If college qualified				
Enrolled in 4-year institution	78.1	89.7	60.1	64.6
Enrolled in less-than-4-year institution	59.3	73.6	47.5	51.7
		Parents have bachelor's or advanced degree		
Total	80.5	81.0	54.5	56.7
College qualified*				
Yes	82.0	82.8	56.4	57.0
No	71.4	72.7	45.9	59.9
If college qualified				
Enrolled in 4-year institution	85.8	84.2	59.1	59.3
Enrolled in less-than-4-year institution	68.3	78.4	46.8	48.9

*Had at least one value on index (high school GPA, rank in class, SAT and ACT test scores, NELS 1992 aptitude test) that placed them in the top 75 percent of 4-year college students.

SOURCE: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study: 1988–94 (NELS:88), Data Analysis System.

Similarly, differences across parents' education were apparent in relation to activities such as visiting a school and seeking out financial aid information (table 17). Among college-qualified seniors, as parental education level increased, so did the likelihood that parents reported they had visited a school with their child at least once while their child was deciding about application or enrollment—from 61 percent of parents of first-generation students, to 71 percent of parents who had some college, to 82 percent of parents with bachelor's degrees. Conversely, parents of college-qualified first-generation students were less likely than other parents (i.e., some college or college graduates) to report seeking out financial aid information (72 versus 83 percent).

Assistance From School Personnel

How did first-generation students compare with others in terms of receiving help from their high school in gathering information about college and the application process? There appeared to be no relationship between parental education level and whether a student reported receiving help from the high school in filling out college applications (table 18). However, college-qualified first-generation students and students whose parents had some college were more likely than students whose parents had bachelor's degrees to specifically report that they had received help from their high school with a financial aid application for college (51 and 47 percent, respectively, versus 34 percent).

There did not appear to be an obvious relationship between parents' education and whether or not a student received help with the college admission application essay.[13] Nor was there an apparent relationship between parents' education level and whether a college-qualified student took days off in high school to visit colleges. Thus, while first-generation students might need to rely on schools for assistance more than students whose parents have had experience in applying to college, with the exception of receiving help with financial aid applications, there was little indication that they had received more assistance in these areas than their counterparts with college-educated parents.

[13]Students whose parents had some college were slightly less likely than students whose parents had bachelor's degrees to indicate receiving help on this aspect of the college application process.

Table 18—Percentage of 1992 high school graduates who reported receiving various types of help from the school in applying to college, by first-generation status, 4-year college qualification index, and 4-year institution enrollment status

	Student received help from school with			
	Admission application	Financial aid application	Admission application essay	Days off to visit postsecondary education institution
Total	48.0	39.7	31.2	42.6
College qualified*				
Yes	51.8	42.1	33.1	45.6
No	40.7	33.9	26.0	35.1
If college qualified				
Enrolled in 4-year institution	56.8	44.4	36.8	51.0
Enrolled in less-than-4-year institution	44.0	38.4	27.3	37.3
First-generation				
Total	47.9	42.0	29.9	39.5
College qualified*				
Yes	55.0	51.0	33.1	46.3
No	39.7	32.0	24.5	33.4
If college qualified				
Enrolled in 4-year institution	59.5	56.5	36.3	51.9
Enrolled in less-than-4-year institution	51.3	46.3	30.5	41.6
Parents have some college				
Total	48.7	44.0	29.5	43.3
College qualified*				
Yes	53.1	47.2	30.5	44.6
No	41.3	36.6	26.6	38.6
If college qualified				
Enrolled in 4-year institution	61.7	53.0	35.2	50.4
Enrolled in less-than-4-year institution	42.5	40.0	24.7	37.7
Parents have bachelor's or advanced degree				
Total	48.8	33.2	34.0	46.7
College qualified*				
Yes	50.4	33.8	35.1	48.4
No	41.9	31.2	28.5	34.7
If college qualified				
Enrolled in 4-year institution	53.0	35.3	37.5	52.3
Enrolled in less-than-4-year institution	42.0	28.7	27.1	35.6

*Had at least one value on index (high school GPA, rank in class, SAT and ACT test scores, NELS 1992 aptitude test) that placed them in the top 75 percent of 4-year college students.

SOURCE: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study: 1988–94 (NELS:88), Data Analysis System.

Controlling for Related Variables

Because many of the variables examined in this analysis are interrelated, it is necessary to use statistical techniques to determine the net effects of individual variables on selected outcomes. In this report, parents' education was the focus of the analysis in determining patterns of educational outcomes. However, family income and family composition (i.e., single-parent versus two-parent households) are also related to parents' education. Similarly, in examining patterns of high school mathematics course taking, the analysis attempted to control for ability by using eighth-grade mathematics proficiency. In order to determine how each of these variables independently affected educational outcomes, the analysis incorporated multiple regression models. Three regression models were used, and all three defined the dependent variable as a dichotomous (yes/no) outcome. The outcomes of the models were defined as (1) the likelihood of completing advanced high school mathematics courses; (2) the likelihood of enrolling in a 4-year college or university; and (3) the likelihood of enrolling in any other postsecondary education among those who did not enroll in a 4-year college. These models included all 1992 high school graduates who had four years of high school transcripts available.[14]

Taking Advanced Mathematics Courses in High School

As illustrated in the tabular analysis, students who took advanced mathematics courses in high school were very likely to enroll in a 4-year college. Nearly two-thirds of first-generation students did so, as did 85 percent of students whose parents were college graduates. These results suggest that taking advanced mathematics courses in high school is an important intermediate step to college enrollment. At the same time, parents' education was also associated with taking advanced mathematics courses even when controlling for mathematics proficiency. Therefore, the first regression model attempted to discern factors that predicted completing advanced mathematics courses, while controlling for parents' education, mathematics proficiency, income and other related variables including student background characteristics. The independent variables included in this model were the following:

[14]Limiting the sample to those with four years of transcripts was necessary to get an accurate accounting of the high school mathematics courses taken. About 80 percent of 1992 high school graduates had all four years of transcripts, and there were no differences in the proportions across the 3 levels of parents' education (NELS:88/94 Data Analysis System).

Students' family background
- Parents' education (some college, college graduates versus high school or less [first-generation])
- Family income (low, middle versus high)
- Single-parent household (versus two parents)

High school characteristics
- Public (versus all private)
- Location (urban and rural versus suburban)

Academic ability and course preparation
- Eighth-grade mathematics proficiency
- Took algebra in the eighth grade

Educational expectations
- Parents (bachelor's degree or higher versus less education)
- Students (bachelor's degree or higher versus less education)

Involvement of individuals in choosing high school academic program
- As reported in eighth grade, the frequency of discussions about high school program (three or more times versus fewer discussions) with:
  - Mother
  - Father
  - School counselor
  - Relatives
  - Friends
- As reported in twelfth grade, individuals who helped students choose their high school academic programs:
  - Parents
  - Teacher or school counselor
  - Close relatives
  - Friends
  - Chose program alone

The results of the regression analysis are presented in table 19. The first column displays the unadjusted percentages—that is, the proportion of students completing any advanced mathematics courses before controlling for the other variables. The second column displays the percentages after adjusting for the covariation among all the variables listed in the table. In other words, they are the expected percentages after holding all other variables constant. The italicized category for each variable is the reference group, against which all comparisons and tests of statistical significance are made. Asterisks indicate when a particular category of a variable is significantly different from the reference group. When asterisks appear in only one column, it means

Table 19—Percentage of 1992 high school graduates who completed any advanced high school mathematics classes (beyond algebra 2) and the adjusted percentage after taking into account the covariation of the variables listed in the table[1]

	Unadjusted percentages[2]	Adjusted percentages[3]	Least squares coefficient[4]	Standard error[5]
Total	39.3	39.2	43.05	3.72
Completed algebra 1 in eighth grade				
Yes	56.5*	57.1*	21.50	1.69
No	*23.7*	*35.6*	†	†
Eighth grade mathematics proficiency[6]				
Below level 1	12.3*	22.3*	-38.84	2.22
Level 1	21.8*	27.5*	-33.67	1.72
Level 2	46.3*	44.3*	-16.86	1.73
Level 3	*78.2*	*61.1*	†	†
First generation status				
Parents with some college	36.4*	38.5*	4.65	1.49
Parents with bachelor's degrees	61.4*	44.6*	10.68	1.80
First generation	*21.7*	*33.9*	†	†
Parents' educational expectations				
Bachelor's degree or higher	52.7*	41.9*	7.83	1.44
Less than bachelor's degree	*18.0*	*34.1*	†	†
Students' educational expectations				
Bachelor's degree or higher	53.7*	46.1*	20.07	1.40
Less than bachelor's degree	*12.3*	*26.0*	†	†
Family income				
Low	27.5*	39.5	-1.42	2.52
Middle	43.5*	38.9	-2.07	2.20
High	*68.9*	*40.9*	†	†
Family composition				
Single parent	31.6*	30.8*	-8.64	4.00
Two parents or guardians	*42.0*	*39.4*	†	†
High school type				
Public	36.7*	37.9*	-14.21	2.13
All other private	*66.6*	*52.1*	†	†
High school location				
Urban	46.1*	41.0*	3.12	1.52
Rural	33.6*	39.7	1.84	1.37
Suburban	*40.3*	*37.9*	†	†

Table 19—Percentage of 1992 high school graduates who completed any advanced high school mathematics classes (beyond algebra 2) and the adjusted percentage after taking into account the covariation of the variables listed in the table[1]—Continued

	Unadjusted percentages[2]	Adjusted percentages[3]	Least squares coefficient[4]	Standard error[5]
Talked to the following individuals about high school program at least 3 times in eighth grade:				
Father				
Yes	46.8*	39.3	0.06	1.45
No	*37.6*	*39.2*	†	†
Mother				
Yes	44.1*	39.8	1.25	1.40
No	*36.3*	*38.6*	†	†
Counselor				
Yes	43.1	39.9	0.75	2.66
No	*40.7*	*39.2*	†	†
Teacher				
Yes	39.4	36.8	-2.60	2.34
No	*41.0*	*39.4*	†	†
Relatives				
Yes	33.9*	35.6*	-4.45	1.64
No	*42.3*	*40.1*	†	†
Friends				
Yes	42.9*	39.6	0.57	1.28
No	*39.0*	*39.0*	†	†
How student chose high school program (reported in 12th grade)				
Alone				
Yes	37.6	42.0*	3.78	1.52
No	*40.8*	*38.2*	†	†
With friends				
Yes	47.9*	41.6*	3.15	1.54
No	*37.4*	*38.5*	†	†
With parents				
Yes	48.6*	43.1*	6.51	1.46
No	*34.0*	*36.6*	†	†
With teacher/counselors				
Yes	41.9	38.9	-0.60	1.37
No	*38.4*	*39.5*	†	†

*$p \leq .05$.

†Not applicable for the reference group.

[1]The italicized group in each category is the reference group being compared.

[2]The estimates are from the NELS:88/94 Data Analysis System.

[3]The percentages are adjusted for differences associated with other variables in the table (see appendix B).

[4]Least squares coefficient is multiplied by 100 to reflect percentage (see appendix B).

[5]Standard error of least squares coefficient, adjusted for design effect, multiplied by 100 to reflect percentage (see appendix B).

[6]Level 1: Can perform simple arithmetical operations on whole numbers. Level 2: Can perform simple operations with decimals, fractions, roots. Level 3: Can perform simple problem solving requiring conceptual understanding or the development of a solution strategy.

SOURCE: U.S. Department of Education, National Center for Education Statistics, 1988–94 National Education Longitudinal Study (NELS:88/94), Data Analysis System.

that the adjustment procedure may lead to a different interpretation than when one uses only unadjusted estimates. For example, before adjustment, family income (shown in the middle of the table) is associated with completion of advanced math courses: students from high-income families were more likely to complete advanced mathematics courses than students from middle- or low-income families. After adjustment, however, there is no significant income effect. This is likely due to the relationship between family income and parents' education. That is, students whose parents are college graduates are much more likely to be from high-income families (as shown in figure 2). Once parents' education and other variables are held constant, the association between income and advanced mathematics course completion disappears. When asterisks appear in both columns, one can draw the same conclusion as when interpreting the tabular results. Often, however, after holding other variables constant, the magnitude of the differences is reduced. Consider, for example, parents' educational expectations. Prior to adjustment 53 percent of students whose parents expected them to attain at least a bachelor's degree had completed advanced mathematics courses, compared with 18 percent whose parents expected them to attain less than a bachelor's degree. After adjustment, the percentages were 42 and 34 percent, respectively.

Examining the overall results, after holding all other variables constant, parents' education continued to be a significant factor associated with whether or not students completed advanced mathematics courses in high school. Compared to first-generation students, those whose parents had some college education and those whose parents attained a bachelor's degree or higher were more likely to complete advanced mathematics courses. Thus, even when controlling for interrelated variables such as income and eighth-grade mathematics proficiency, first-generation students were still at a disadvantage in their likelihood of completing an advanced mathematics program important for college enrollment. At the same time, taking algebra in the eighth grade provided an advantage in the likelihood of completing advanced mathematics courses in high school, despite differences in parents' education. That is, even after controlling for mathematics proficiency and parents' education as well as all other variables, taking algebra in the eighth grade still increased students' chances of completing advanced high school mathematics courses.

Other variables associated with higher rates of advanced mathematics course completion included reporting educational aspirations of at least a bachelor's degree (for both student- and parent-reported aspirations), compared to those reporting lower aspirations; attending a private high school (versus public), and attending an urban high school (versus suburban).

After adjustment, the significance of some of the involvement variables (second page of table) changed. Eighth-graders who reported having three or more discussions about their high school program with various individuals including mother, father, and friends were no longer

significantly more likely to complete advanced mathematics courses. On the other hand, students whose parents helped them choose their high school programs (as reported in the twelfth grade) completed advanced mathematics courses at higher rates than those who did not have their parents' help. The same was true for students who reported choosing their high school programs with friends. That is, after controlling for related variables, students who reported that their friends helped them choose their high school programs were more likely to complete advanced mathematics courses than those who reported otherwise.

In contrast, both before and after adjustment, being from a single-parent household was negatively associated with completing advanced mathematics courses in high school. Single parents may face economic and time pressures that make it more difficult than it might be for two-parent families to participate in their children's schooling. Because of these time constraints, the parent may not obtain the knowledge about the importance of taking advanced mathematics, and may not have the time to spend with the student in planning a mathematics program.

Finally there were two results, one positive and one negative, that were difficult to interpret. A result that became positive only after adjustment was for students who reported choosing their high school programs alone. Students who reported choosing their high school programs alone were more likely to complete advanced mathematics classes. It is not clear why this variable obtained significance after controlling for related variables. But it might be that once factors related to not having family support (such as family income, parents' education, single-parent household) were held constant, students who reported choosing their high school programs alone might be those who are confident in their knowledge and ability to choose courses that advance their academic standing.

The negative result emerged for students who reported discussing their future high school programs with their relatives (as reported in the eighth grade). It is possible that students whose parents are not able to provide enough guidance may instead turn to relatives for advice. Alternatively, some students may have rejected their parents' advice and turned to relatives for other options. In any case, the differences in advanced mathematics completion rates between the comparison groups for the two variables in question (i.e., talked with relatives versus others and chose program alone versus others), in practical terms, are relatively small (36 versus 40 percent and 42 versus 39 percent, respectively).

Enrollment in College

In the tabular analysis, parents' education was also strongly associated with whether or not 1992 high school graduates enrolled in college. This was found for enrollment at the 4-year level

as well as for enrollment in any postsecondary education. However, many factors may affect the likelihood of college enrollment, especially measures of academic preparation. Therefore, in the models used to estimate the independent effects of selected variables on college enrollment, both the level of college qualification and of mathematics courses taken in high school were held constant. The independent variables for the two college enrollment models included the following:

Students' family background
- Parents' education (some college, college graduates versus high school or less [first-generation])
- Family income (low, middle versus high)
- Single-parent household (versus two parents)

High school characteristics
- Public (versus all private)
- Location (urban and rural versus suburban)

Academic ability and course preparation
- Took algebra in the eighth grade
- Mathematics course levels (low, middle academic I, middle academic II versus advanced)
- College qualification index (minimally to somewhat qualified and very to highly qualified versus marginally to not qualified)

Educational expectations
- Parents (bachelor's degree or higher versus less education)
- Students (bachelor's degree or higher versus less education)

Involvement of parents in preparing for college
- Discuss SAT/ACT preparation (often and sometimes versus never)
- Discuss postsecondary education preparation (often and sometimes versus never)
- Attend programs about financial aid availability

Friends' plans for college
- Most or all friends plan to attend 4-year college (versus few to none)

School help in application process
- Took a class to prepare for SAT
- Got help filling out application

Other school activities
- Extracurricular activities (one, two versus none)

Enrollment in 4-Year Institutions

Table 20 illustrates that even after controlling for measures of academic preparation, income, and other variables, students whose parents were college graduates were more likely than first-generation students to enroll in a 4-year college. Unlike the findings for the previous model, however, students whose parents had some college did not appear to have an advantage over first-generation students in their likelihood of enrolling in a 4-year college.

The regression analysis confirmed the importance of taking advanced high school mathematics courses for enrolling in 4-year colleges. Even when controlling for level of college qualification, parents' education, and other related variables, students who took advanced mathematics courses were significantly more likely to enroll in 4-year colleges than those who took lower level courses, up to and including courses through algebra 2. The fact that taking algebra in eighth grade is not significantly associated with increased college enrollment demonstrates its indirect effect on the outcome. That is, taking algebra in eighth grade significantly increases the likelihood of completing advanced mathematics classes in high school, which in turn increases students' chances of enrolling in a 4-year college.

Another result which was different from the previous model had to do with the influence of family income. While family income had no significant effect on the likelihood of taking advanced mathematics courses after controlling for related variables, being from a high-income family increased students' likelihood of enrolling in a higher 4-year college, both before and after adjustment. After adjustment, however, low- and middle-income students enrolled at similar rates. This last finding may reflect the leveraging effect of financial aid in providing access to college for low-income students. The finding is consistent with an earlier study examining access to postsecondary education (Berkner and Chavez 1997), which showed similar 4-year college enrollment rates for low- and middle-income students if they were academically qualified for admission and they took the necessary steps to apply. Correspondingly, the current model illustrates the effect of parents attending programs about financial aid availability on students' enrollment in college. That is, controlling for all other variables, students whose parents reported attending such programs were more likely to enroll than students whose parents did not attend (second page of table).

Other positive influences on 4-year college enrollment illuminated the importance of parent participation in college preparation activities. If students sometimes had conversations with their parents about preparing for entrance exams or if they often discussed planning for college, they were more likely to enroll than those who reported having no such conversations. Obtaining help from the school in the application process also remained significant after holding related variables constant.

Table 20—Percentage of 1992 high school graduates who enrolled in a 4-year institution by 1994 and the adjusted percentage after taking into account the covariation of the variables listed in the table

	Unadjusted Percentages[2]	Adjusted percentages[3]	Least squares coefficient[4]	Standard error[5]
Total	45.9	45.7	17.98	4.23
Completed algebra 1 in eighth grade				
Yes	59.5*	48.0	2.80	1.69
No	*33.3*	*45.2*	†	†
High school mathematics course level				
No mathematics/low academic courses	6.1*	37.0*	-18.21	3.05
Middle academic I (algebra 1 and geometry)	15.7*	36.3*	-18.87	3.06
Middle academic II (algebra 2)	43.9*	40.3*	-14.83	1.62
Advanced academic (beyond algebra 2)[6]	*76.0*	*55.2*	†	†
First generation status				
Parents with some college	41.6*	43.6	1.28	1.52
Parents with bachelor's degrees	70.8*	51.1*	8.80	1.83
First generation	*26.9*	*42.3*	†	†
Level of qualification for 4-year college				
Minimally to somewhat qualified	43.2*	44.9*	12.67	1.61
Very to highly qualified	78.2*	59.2*	26.97	1.99
Marginally or not qualified	*12.7*	*32.2*	†	†
Parents' educational expectations				
Parents expect bachelor's degree or higher	60.8*	47.8*	6.03	1.49
Less than bachelor's degree	*20.9*	*41.7*	†	†
Students' educational expectations				
Bachelor's degree or higher	61.4*	49.1*	10.03	1.52
Less than bachelor's degree	*16.4*	*39.1*	†	†
Family income				
Low	32.4*	44.3*	-12.63	2.58
Middle	49.4*	44.8*	-12.13	2.26
High	*83.2*	*56.9*	†	†
Family composition				
Single parent	40.1*	43.5	-2.27	4.05
Two parents or guardians	*48.3*	*45.7*	†	†
Discussions with parents about SAT/ACT exams				
Sometimes	51.2*	46.8*	3.20	1.52
Often	65.7*	46.0	2.40	2.07
Never	*29.9*	*43.6*	†	†

Table 20—Percentage of 1992 high school graduates who enrolled in a 4-year institution by 1994 and the adjusted percentage after taking into account the covariation of the variables listed in the table —Continued

	Unadjusted Percentages[2]	Adjusted percentages[3]	Least squares coefficient[4]	Standard error[5]
Discussions with parents about postsecondary plans				
Sometimes	38.7*	41.6	0.91	2.08
Often	67.1*	51.5*	10.76	2.34
Never	*12.2*	*40.7*	†	†
Parents attended program about financial aid				
Yes	65.6*	51.9*	10.03	1.28
No	*36.9*	*41.9*	†	†
School provided help with college application				
Yes	56.2*	48.3*	4.98	1.21
No	*40.3*	*43.3*	†	†
Took class to prepare for SAT				
Yes	59.1*	48.6*	3.56	1.56
No	*44.8*	*45.1*	†	†
Number of friends with 4-year college plans				
Most to all	63.5*	50.2*	11.96	1.33
One or none	*23.9*	*38.3*	†	†
Number of high school extracurricular activities				
One	42.0*	44.3	-0.34	1.74
Two or more	58.9*	47.6	2.93	1.84
None	*29.0*	*44.7*	†	†
High school type				
Public	43.5*	45.4	-2.90	2.18
All other private	*71.3*	*48.3*	†	†
High school location				
Urban	51.5	45.7	0.82	1.55
Rural	40.9*	46.8	1.91	1.39
Suburban	*46.9*	*44.8*	†	†

*$p \leq .05$.

†Not applicable for the reference group.

[1]The italicized group in each category is the reference group being compared.

[2]The estimates are from the NELS:88/94 Data Analysis System.

[3]The percentages are adjusted for differences associated with other variables in the table (see appendix B).

[4]Least squares coefficient is multiplied by 100 to reflect percentage (see appendix B).

[5]Standard error of least squares coefficient, adjusted for design effect, multiplied by 100 to reflect percentage (see appendix B).

[6]Completed at least one class beyond algebra 2 labeled "advanced" including precalculus, calculus, trigonometry, probability, statistics, algebra 3, etc.

SOURCE: U.S. Department of Education, National Center for Education Statistics, 1988–94 National Education Longitudinal Study (NELS:88/94), Data Analysis System.

Finally, the strong effect of having friends with college plans on the likelihood of students enrolling in a 4-year college is notable. Similar to the positive effect of having peer support in choosing their high school programs, students who reported that most or all of their friends planned to attend a 4-year college were much more likely to enroll themselves than students who had one or no friends with such plans.

Enrollment in Other Postsecondary Education

The findings for enrolling in other types of postsecondary education (primarily public 2-year colleges) after excluding those who enrolled at the 4-year level are displayed in table 21. Like 4-year college enrollment, parents' education continued to make a difference. In fact, even students whose parents had some college education were more likely to enroll in some form of postsecondary education than were first-generation students. Family income, on the other hand, did not appear to have a direct effect on enrollment on postsecondary education outside the 4-year level. Similarly, mathematics course taking in high school had no measurable influence on whether or not students enrolled in postsecondary education at the sub-baccalaureate level. On the other hand, if students were at least minimally qualified for admission to a 4-year college or they had aspirations for at least a bachelor's degree, they were more likely to enroll in some postsecondary education.

As was true for those who enrolled at the 4-year level, indicators of parent involvement had a positive effect on enrollment in other types of postsecondary education. Students who discussed postsecondary education plans with their parents and those whose parents attended programs about financial aid availability were more likely to enroll in some type of postsecondary education than their counterparts who did not have such discussions or whose parents did not attend such programs.

Finally, school-level variables were also associated with postsecondary education enrollment. Students who reported getting assistance from their high school in applying to postsecondary education programs enrolled at higher rates than those who reported no such assistance. In contrast, attending a rural high school was associated with lower rates of enrollment than attending a suburban high school. The latter result may reflect fewer opportunities to attend local community colleges because there are many more community colleges located in urban and suburban areas.

In summary, while controlling for the interrelationships of related variables, parents' education had an independent effect on all the outcomes analyzed in the multivariate analysis. Even when compared to students whose parents had some postsecondary education, short of a

Table 21—Among 1992 high school graduates who did not enroll in 4-year institutions, the percentage who enrolled in any other postsecondary education and the adjusted percentage after taking into account the covariation of the variables listed in the table[1]

	Unadjusted Percentages[2]	Adjusted percentages[3]	Least squares coefficient[4]	Standard error[5]
Total	55.0	55.0	29.14	11.25
Completed algebra 1 in eighth grade				
Yes	61.0*	54.7	-0.34	4.78
No	*51.6*	*55.0*	†	†
High school mathematics course level				
No mathematics/low academic courses	37.8*	47.9	-8.15	5.85
Middle academic I (algebra 1 and geometry)	49.9*	58.4	2.40	5.84
Middle academic II (algebra 2)	63.5*	55.4	-0.62	3.96
Advanced academic (beyond algebra 2)[6]	*72.3*	*56.0*	†	†
First generation status				
Parents with some college	59.3*	56.9*	7.63	2.93
Parents with bachelor's degrees	73.6*	61.9*	12.64	4.13
First generation	*43.0*	*49.3*	†	†
Level of qualification for 4-year college				
Minimally to somewhat qualified	65.0*	61.3*	12.69	3.04
Very to highly qualified	75.1*	62.5*	13.89	4.55
Marginally or not qualified	*42.7*	*48.6*	†	†
Parents' educational expectations				
Parents expect bachelor's degree or higher	67.2*	57.4	4.75	2.94
Less than bachelor's degree	*44.7*	*52.6*	†	†
Students' educational expectations				
Bachelor's degree or higher	67.8*	59.0*	7.58	2.93
Less than bachelor's degree	*44.3*	*51.4*	†	†
Family income				
Low	44.7*	49.8	-7.99	8.27
Middle	62.5	58.3	0.49	7.94
High	*73.4*	*57.8*	†	†
Family composition				
Single parent	52.1	66.8	12.09	7.95
Dual parents or guardians	*56.0*	*54.7*	†	†
Discussion with parents about SAT/ACT exams				
Sometimes	63.4*	55.9	0.07	3.20
Often	66.8*	48.8	-7.01	5.12
Never	*44.2*	*55.8*	†	†

Table 21—Among 1992 high school graduates who did not enroll in 4-year institutions, the percentage who enrolled in any other postsecondary education and the adjusted percentage after taking into account the covariation of the variables listed in the table[1]—Continued

	Unadjusted Percentages[2]	Adjusted percentages[3]	Least squares coefficient[4]	Standard error[5]
Discussions with parents about postsecondary plans				
Sometimes	59.0*	56.4*	19.12	3.77
Often	71.7*	66.7*	29.48	4.71
Never	*29.8*	*37.3*	†	†
Parents attended program about financial aid				
Yes	70.9*	61.6*	8.87	3.04
No	*51.9*	*52.7*	†	†
School provided help with college application				
Yes	64.4*	58.4*	5.73	2.68
No	*54.9*	*52.7*	†	†
Took class for SAT				
Yes	61.4	56.0	1.16	3.74
No	*55.6*	*54.8*	†	†
Number of friends with 4-year college plans				
Most to all	64.8*	55.3	0.55	2.69
One or none	*50.0*	*54.7*	†	†
Number of high school extracurricular activities				
One	55.5	54.1	-1.84	3.39
Two or more	61.3*	55.8	-0.05	3.75
None	*49.4*	*55.9*	†	†
High school type				
Public	54.2*	54.7	-6.39	6.28
All other private	*74.8*	*61.1*	†	†
High school location				
Urban	57.2	55.2	-3.32	3.49
Rural	47.8*	50.9*	-7.60	2.96
Suburban	*60.7*	*58.5*	†	†

*$p \leq .05$.

†Not applicable for the reference group.

[1]The italicized group in each category is the reference group being compared.

[2]The estimates are from the NELS:88/94 Data Analysis System.

[3]The percentages are adjusted for differences associated with other variables in the table (see appendix B).

[4]Least squares coefficient is multiplied by 100 to reflect percentage (see appendix B).

[5]Standard error of least squares coefficient, adjusted for design effect, multiplied by 100 to reflect percentage (see appendix B).

[6]Completed at least one class beyond algebra 2 labeled "advanced" including precalculus, calculus, trigonometry, probability, statistics, algebra 3, etc.

SOURCE: U.S. Department of Education, National Center for Education Statistics, 1988–94 National Education Longitudinal Study (NELS:88/94), Data Analysis System.

bachelor's degree, first-generation students were less likely to take advanced mathematics courses in high school, and to enroll in postsecondary education except at the 4-year level. With respect to 4-year college enrollment, first-generation students were no less likely than students whose parents had some postsecondary education to enroll; however, both of these groups enrolled at lower rates than those of students whose parents had attained bachelor's degrees or higher levels of education. At the same time, regardless of parents' education, family income, academic preparation, and other related variables, taking algebra in the eighth grade increased students' chances of completing advanced mathematics courses in high school. In turn, completing any advanced mathematics courses in high school increased students' chances of enrolling in a 4-year college. However, after removing students who enrolled in 4-year colleges and looking only at whether or not the remaining students enrolled in any other postsecondary education, neither taking algebra in the eighth grade nor completing advanced high school mathematics was associated with higher rates of enrollment.

Summary and Conclusions

The findings from this study indicate that, regardless of academic achievement and income levels, first-generation students—who represent at least one-quarter of high school graduates—are less likely than their counterparts whose parents have more education to participate in mathematics curricula and planning activities that lead to college enrollment. Consequently, they are less likely to enroll in college even when qualified for admission. In trying to discern why these differences are so pervasive, the study examined how students interacted with their parents, teachers, counselors, and other individuals in choosing their academic courses, and whether they received assistance from their high school in applying to college. The results of the analysis suggest that a comparative lack of information from parents, schools, and family agents may account for some of the discrepancies in the rates at which first-generation students and others enroll in higher level mathematics courses and in postsecondary education.

According to this study, first-generation students and, in many instances, students whose parents have some college but less than a bachelor's degree interact less often with their parents about matters relating to choosing courses and applying to college than those whose parents have more education. Moreover, parents with no higher education than a high school diploma are less likely to participate in activities related to obtaining information about applying to college. This pattern held even among students who were at least minimally qualified for admission to a 4-year college.

Given that first-generation students interact less frequently with parents, it might be expected they would interact more often with teachers, counselors, principals, and others about these matters. Yet, in this analysis, this did not appear to be the case. First-generation students were no more likely (and in some cases less likely) than other students to report that teachers and other school personnel were involved in encouraging them to take algebra in the eighth grade and in choosing their high school program. There were two instances, however, in which first-generation students did report receiving assistance from a counselor or the school more often than their counterparts whose parents had graduated from college. The first was in choosing a mathematics class to take in their senior year (among those who took mathematics in the twelfth grade), and the second was in applying for financial aid. This assistance, however, occurred at the end of students' high school years when, according to this study, as early as the eighth grade,

first-generation students could have taken measures to improve their chances of enrolling in college.

On the positive side, results based on a multivariate analysis indicated that regardless of parents' education, income, academic achievement, and other related factors, students who took algebra in the eighth grade increased their chances of completing advanced-level mathematics courses in high school. Correspondingly, students who took advanced mathematics courses, regardless of their high school academic preparation and their parents' education, income, and other factors, significantly increased their chances of enrolling in a 4-year college. In addition, students whose parents were involved in helping them choose their academic program and prepare for applying to college were also more likely to have better educational outcomes than their counterparts whose parents were not involved.

It is possible, therefore, that providing first-generation students and parents with key information about choosing courses and applying to college well before high school would enable more first-generation students to follow the path to college. Moreover, special efforts to offer less-educated parents opportunities to become more effectively involved and engaged in their children's education might increase their abilities to encourage their children to pursue higher-level courses and, eventually, a college education.

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Appendix A—Glossary

This glossary describes the variables used in this report. The items were taken directly from the National Education Longitudinal Study (NELS:88/94) Data Analysis System (DAS) (see appendix B for a description of the DAS). The variables used in this analysis were either items taken directly from the NELS surveys or they were derived by combining one or more items in these surveys. For direct survey items, those variable names beginning with "BY" were collected in the base year (1988), "F1" variables were collected in the first followup (1990), F2 in the second followup (1992), and F3 in the third (1994).

For the critical variables used in the analysis, none had more than 15 percent missing a valid response. Missing cases were removed from the analysis. The variables listed in the index below are in the order they appear in the report; the glossary is in alphabetical order by DAS variable name (displayed along the right-hand column).

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Algebra in the 8th grade **ALGCOMP**

Student transcripts were examined to determine whether or not students took the equivalent of high school algebra in the 8th grade. If algebra 1 was not recorded on the transcript and student took higher level courses (such as geometry or algebra 2), it was assumed that the student completed algebra in the 8th grade. For those for whom transcripts were not available (roughly 15 percent), if students reported taking algebra in the 8th grade, they were coded as having done so.

Math proficiency 1988 **BY2XMPRO**

The mathematics tests taken by the eighth graders in NELS:88 were designed so that the test results were reported both as simple numbers and as performance levels. Proficiency calculations used a refinement of the student weight that adjusts for the fact that not all students who completed the base-year questionnaire completed the cognitive tests.

Below Level 1	Student cannot perform simple arithmetical operations on whole numbers.
At Level 1 but below Levels 2 and 3	Student can perform at level 1, but below level 2.
At Level 1 and 2 but below Level 3	Student can perform simple operations with decimals, fractions, and roots, but can not perform at level 3.
Proficient at all 3 levels	Student can perform at lower levels and can do simple problem solving requiring conceptual understanding or the development of a solution strategy.

Family composition 1988 **BYFCOMP**

Indicates student's family or household composition

Both parents or parent and guardian	Student's family or household consisted of both mother and father or mother and male guardian or father and female guardian.
Single parent	Student's family or household consisted of mother only or father only.

Parents' educational expectations 1988 **BYP76**

Parent response to the question "How far in school do you expect your eighth grader to go?"

High school diploma or less	Parents expected student to complete no more than a high school diploma.
Some college	Parents expected student to attain some postsecondary education, but short of a bachelor's degree.
Bachelor's degree or higher	Parents expected student to attain a bachelor's degree or higher.

Educational expectations 1988 **BYS45**

Student response to the question "As things stand now, how far in school do you think you will get?"

No postsecondary education
Some college or vocational training
Bachelor's degree
Advanced degree

Talk to father about planning high school program **BYS50A**

Student response to the question "How often have you talked to the following people about planning your high school program?"

BYS50A	Your father (or male guardian)
BYS50B	Your mother (or female guardian)
BYS50C	A guidance counselor
BYS50D	Teachers
BYS50E	Other adult relatives or friends
BYS50F	Friends or relatives about your own age

Possible responses were once or twice and three or more times. Students who reported talking to the individuals listed above 3 or more times are included in this analysis.

Talk to mother about planning high school program **BYS50B**

Indicates how often student reported talking to mother about planning high school program. Students who reported talking to his/her mother three or more times are included in this analysis. For complete description, see BYS50A.

Talk to counselor about planning high school program **BYS50C**

Indicates how often student reported talking to counselor about planning high school program. Students who reported talking to their counselors three or more times are included in this analysis. For complete description, see BYS50A.

Talk to teachers about planning high school program **BYS50D**

Indicates how often student reported talking to teachers about planning high school program. Students who reported talking to their teachers three or more times are included in this analysis. For complete description, see BYS50A.

Talk to relatives about planning high school program **BYS50E**

Indicates how often student reported talking to relatives about planning high school program. Students who reported talking to their relatives three or more times are included in this analysis. For complete description, see BYS50A.

Talk to friends about planning high school program **BYS50F**

Indicates how often student reported talking to friends about planning high school program. Students who reported talking to their friends three or more times are included in this analysis. For complete description, see BYS50A.

Student talked to teacher/counselor about taking algebra **BYS61**

Student response to the question "Did a teacher or counselor talk to you about taking an algebra course this year?" Students who reported that a teacher or counselor encouraged them to take algebra are included in this analysis.

Parents wanted student to take algebra **BYS62**

Student response to the question "Did your parents/guardians want you to take an algebra course this year?" Students who reported that parents/guardians encouraged them to take algebra are included in this analysis.

Friends encouraged student to take algebra **BYS63**

Student response to the question "Did your friends encourage you or discourage you from taking algebra this year?" Students who reported that friends encouraged them to take algebra are included in this analysis.

Asked to take algebra by principal **BYS64**

Student response to the question "Were you asked by the principal or another school staff member if you wanted to take an algebra course?" Students who reported that the principal or another school staff member encouraged them to take algebra are included in this analysis.

College qualification index **CQCOMV2**

A composite index of 4-year college readiness or qualification based on the five measures of academic performance: cumulative academic coursework GPAs, senior class rank, the NELS 1992 test scores, and the SAT and ACT college entrance examination scores. Since admission standards and requirements vary widely among 4-year colleges and universities, the approach used here was to examine the actual distribution of these five measures of academic aptitude and achievement among those graduating seniors who did attend a 4-year college or university. Data sources were available for approximately half (45 percent) of the NELS graduating seniors for four or five of the criteria: class rank, GPA, the NELS test, and ACT or SAT scores or both. For about one-third of the seniors there were only three data sources available because they had no ACT or SAT scores. All of these students had NELS test scores, however. In order to identify as many students as possible who were potentially academically qualified for a 4-year college, even if data were missing for these students on some of the criteria, the seniors were classified according to the *highest* level they had achieved on *any* of the five criteria for which data were present.

The classification of the graduating seniors was determined as follows (for the analysis in this report the "somewhat" and "minimally" qualified categories were combined):

- *Highly qualified*: those whose highest value on any of the five criteria would put them among the top 10 percent of four-year college students (specifically the NELS 1992 graduating seniors who enrolled in 4-year colleges and universities) for that criterion. Minimum values were GPA=3.7, class rank percentile=96, NELS test percentile=97, combined SAT=1250, composite ACT=28.

- *Very qualified*: those whose highest value on any of the five criteria would put them among the top 25 percent of 4-year college students for that criterion. Minimum values were GPA=3.6, class rank percentile=89, NELS test percentile=90, combined SAT=1110, composite ACT=25.
- *Somewhat qualified*: those whose highest value on any of the five criteria would put them among the top 50 percent of 4-year college students for that criterion. Minimum values were GPA=3.2, class rank percentile=76, NELS test percentile=56, combined SAT=960, composite ACT=22.
- *Minimally qualified*: those whose highest value on any of the five criteria would put them among the top 75 percent of 4-year college students for that criterion. Minimum values were GPA=2.7, class rank percentile=54, NELS test percentile=56, combined SAT=820, composite ACT=19.
- *Marginally or not qualified*: those who had no value on any criterion that would put them among the top 75 percent of four-year college students (i.e., all values were in the lowest quartile). In a few instances either because of missing data or because students were considered special admissions, about 10 percent of the students who were identified as not qualified had enrolled in 4-year institutions.

Subsequently, some adjustments were made for programs of rigorous academic coursework, defined as including at least 4 years of English; 3 years each of science, mathematics, and social studies; and 2 years of a foreign language. Those who had taken a program of rigorous academic courses were moved up into the next highest level of qualification. Those in the "highly qualified" category were moved down into the "very qualified" category if they had not taken the rigorous academic coursework defined here.

Students' extracurricular activities **F1EXCUR**

Number of extracurricular activities in a variety of areas reported by the student in 1990. Includes sports, band, theater, student government, academic societies, yearbook, service clubs, and hobby clubs. The variable was aggregated as follows:

None	Student did not participate in any extracurricular activities.
One	Student participated in one extracurricular activity.
Two or more	Student participated in two or more extracurricular activities.

Educational expectations 1990 **F1S49**

Student response to the question "As things stand now, how far in school do you think you will get?"

No postsecondary education
Some college or vocational training
Bachelor's degree
Advanced degree

How often discussed SAT/ACT prep with parents - 10th grade **F1S105F**

Indicates how often student reported discussing SAT/ACT preparation with parents in the 10th grade

Never
Sometimes
Often

How often discussed postsecondary plans with parents - 10th grade **F1S105G**

Indicates how often student reported discussing postsecondary education plans with parents in the 10th grade

Never
Sometimes
Often

Number of friends who plan to attend a 4-year college **F2FRCOLL**

Based on the item BYS69E: "How many of your friends plan to attend a 4-year college?" asked on the 1992 survey.

None	None of student's friends planned to attend 4-year college.
Few to some	Few to some friends planned to attend 4-year college.
Most to all	Most or all of student's friends planned to attend 4-year college.

Attend program on educational opportunities **F2P45AR**

Parent response to the question "Since this past fall, or during the last year your teenager attended school, did you or your spouse/partner attend any of the following types of programs dealing with opportunities for your teenager?

F2P45AR	A program on educational opportunities after completing high school
F2P45BR	A program on financial aid for colleges, universities, or vocational technical schools
F2P45CR	A program on employment and career opportunities

Parents who replied that they attended the individual programs listed above are included in this analysis.

Attend program about postsecondary education aid **F2P45BR**

Indicates whether parent reported attending a program on educational opportunities for student after completing high school. Students whose parents reported attending a program about postsecondary education financial aid are included in this analysis. For complete description see F2P45AR.

Attend program about work opportunities **F2P45CR**

Indicates whether parent reported attending a program about work opportunities for student after completing high school. Students whose parents reported attending a program about work opportunities are included in this analysis. For complete description see F2P45AR.

How many schools visited with child **F2P67R**

Parent's response to the question "When you and/or your teenager were deciding which school he/she would attend after high school, how many different schools did you visit with him/her?" Students who parents replied that they visited at least one postsecondary institution are included in this analysis.

Family income 1991 **F2P74**

In 1992, parents were asked, "What was your total gross family income from all sources before taxes in 1991 (If you are not sure of the amount, please estimate)?" For purposes of this report, the original 13 income categories were collapsed into three.

Low (less than $25,000)	Family income was less than $25,000.
Middle ($25,000–$74,999)	Family income was between $25,000 and $74,999.
High ($75,000 or higher)	Family income was $75,000 or higher.

Sought financial aid information **F2P83R**

Parent's response to the question "Have you talked to anyone or read anything about sources of financial aid for education after high school for your teenager?" Students whose parents replied that they sought financial aid information are included in this analysis.

Talked with a high school guidance counselor about financial aid **F2P84A**

Indicates whether parents talked with guidance counselor about financial aid for their child's postsecondary education. Students whose parents indicated that did talk with a guidance counselor are included in this analysis.

Talked with a college representative **F2P84B**

Indicates whether parents talked with a college representative about financial aid for their child's postsecondary education. Students whose parents indicated that did talk with a college representative are included in this analysis.

Was assigned high school program **F2S12BAR**

Student response to the question "How did you get into this program?"

F2S12BAR	I was assigned
F2S12BBR	I chose it after talking to my counselor or teacher
F2S12BCR	I chose it after talking to my parents
F2S12BDR	I chose it after talking to my friends
F2S12BER	I chose it myself - did not consult anyone
F2S12BFR	This is the only program at my school

Students who replied that they were assigned to their high school program are included in this analysis.

Chose high school program with teacher/counselor **F2S12BBR**

Indicates whether student chose high school program with teacher/counselor. Students who replied that that they chose their high school program after talking to their teacher/counselor are included in this analysis. For complete description see F2S12BAR.

Chose high school program with parents **F2S12BCR**

Indicates whether student chose high school program with parents. Students who replied that that they chose their high school program after talking to their parents are included in this analysis. For complete description see F2S12BAR.

Chose high school program with friends **F2S12BDR**

Indicates whether student chose high school program with friends. Students who replied that that they chose their high school program after talking to their friends are included in this analysis. For complete description see F2S12BAR.

Chose high school program alone **F2S12BER**

Indicates whether student chose high school program alone. Students who replied that that they did not consult anyone about choosing their school program are included in this analysis. For complete description see F2S12BAR.

Only one high school program available **F2S12BFR**

Indicates whether high school program in which student was enrolled was the only program available. Students who replied that there was only one high school program available are included in this analysis. For complete description see F2S12BAR.

Took math in twelfth grade **F2S22AR**

Twelfth grader's response to the question "Are you taking a mathematics class this term?" Students who replied "yes" are included in this analysis.

Importance of teacher in taking math **F2S22BAR**

Student response to the question "How important was each of the following people in your decision to take the math course you are taking this term?"

F2S22BA	Your teacher(s)
F2S22BB	Your guidance counselor
F2S22BC	Your parent(s)
F2S22BD	Your friend(s)

Students who replied that the individuals listed above played a very or somewhat important role in choosing their math course are included in this analysis.

Importance of counselor in taking math **F2S22BBR**

Indicates how important students considered their counselor's role in helping them choose the math course that they were taking at survey time. Students who replied that a counselor played a very or somewhat important role in choosing their math course are included in this analysis. For complete description see F2S22BAR.

Importance of parents in taking math **F2S22BCR**

Indicates how important students considered their parents' role in helping them choose the math course that they were taking at survey time. Students who replied that their parents played a very or somewhat important role in choosing their math course are included in this analysis. For complete description see F2S22BAR.

Importance of friends in taking math **F2S22BDR**

Indicates how important students considered their friends' role in helping them choose the math course that they were taking at survey time. Students who replied that their friends played a very or somewhat important role in choosing their math course are included in this analysis. For complete description see F2S22BAR. For complete description see F2S22BAR.

High school help with admission application 1992 **F2S57A**

Student response to the questions "At your high school, have you received..."

F2S57A	Help with filling out vocational/technical school or college applications?
F2S57B	Help with filling out financial aid forms?
F2S57C	Assistance in writing essays for vocational/technical school or college applications?
F2S57D	Days off from school to visit vocational/technical schools or colleges?

Students who replied that they received such school assistance are included in this analysis.

High school help with financial aid application 1992 **F2S57B**

Indicates whether or not student reported receiving help from high school with financial aid application. Students who replied that they received help from their high school with the financial aid application are included in this analysis. For complete description see F2S57A.

High school help with admission application essay 1992 **F2S57C**

Indicates whether or not student reported receiving help from high school with admission application essay. Students who replied that they received help from their high school with the admission application essay are included in this analysis. For complete description see F2S57A.

Days off to visit postsecondary education institution **F2S57D**

Indicates whether or not student reported receiving days off from high school to visit postsecondary education institutions. Students who replied that they did receive days off are included in this analysis. For complete description see F2S57A.

How often discussed SAT/ACT preparation with parents - 12th grade **F2S99E**

Indicates how often student reported discussing SAT/ACT preparation with parents in the 12th grade.

Never
Sometimes
Often

How often discuss postsecondary plans with parents - 12th grade **F2S99F**

Indicates how often student reported discussing postsecondary plans with parents in the 12th grade.

Never
Sometimes
Often

Parents' highest education level/first generation status **F2PARED**

This composite variable characterizes the level of education attained by the student's parent with the highest reported education level. It was constructed using the second follow-up parent questionnaire data. New student supplement data were used if parent data were missing. For this analysis, the variable was aggregated as follows:

First generation	Both parents have no more than a high school education. Thus, the student would be a member of the first generation in the immediate family to attend college.
Some college	One or both parents have some postsecondary education, but less than a bachelor's degree. This includes vocational certificates and associate's degrees.
College graduate	One or both parents earned a bachelor's degree or higher.

Race/ethnicity **F3RACE**

Based on the 1992 response unless it was missing or incorrect. In addition, if it became apparent from responses to other questions that the 1992 response was incorrect, the value was corrected in 1994. Sample members with the value of "Other" were coded as missing for the analysis.

Asian/Pacific Islander	A person having origins in any of the Pacific Islander peoples of the Far East, Southeast Asia, the Indian subcontinent, or Pacific Islands. This includes people from China, Japan, Korea, the Philippine Islands, Samoa, India, and Vietnam.
Hispanic	A person of Mexican, Puerto Rican, Cuban, Central or South American, or other Spanish culture or origin, regardless of race.
Black, non-Hispanic	A person having origins in any of the black racial groups of Africa, not of Hispanic origin.

White, non-Hispanic	A person having origins in any of the original peoples of Europe, North Africa, or the Middle East (except those of Hispanic origin).
American Indian/Alaskan Native	A person having origins in any of the original peoples of North America and who maintains cultural identification through tribal affiliation or community recognition.

Postsecondary institution **F3SEC2A1**

This variable indicates the type of postsecondary institution first attended by the student. The primary source is the SECTOR variable in the 1993/94 Integrated Postsecondary Education Data System (IPEDS) data file. In the few instances where SECTOR is missing, the variable CONTROL from the same file is used. In this report categories were aggregated as follows:

Did not enroll	Student had not enrolled in any postsecondary education by 1994.
4-year institution	Student was enrolled in a public or private, not-for-profit 4-year institution.
Public, 2-year	Student was enrolled in a public 2-year institution.
Other	Student was enrolled in a public, less-than-2-year institution; a private, not-for-profit less-than-4-year institution; or a private, for-profit institution.

Gender **F3SEX**

Male
Female

School location **G12URBN3**

Trichotomizes the urbanicity of the area in which the sample member's second follow-up school is located. This metropolitan status is defined by QED for public school districts, for Catholic dioceses, or in some cases for the county in which the school is located. QED bases the classifications on the Federal Information Processing Standards as used by the U.S. Census.

Urban
Suburban
Rural

Highest level math courses completed **MTHQUAL8**

This variable describes the level of the highest sequence of math courses student completed in high school. It is based on high school transcripts. For this analysis, the variable was aggregated as follows:

No math/low or nonacademic	Student did not take any math courses; took non-academic or low academic courses including those classified as "general mathematics" or "basic skills mathematics"; low academic courses which comprise preliminary (e.g., pre-algebra) or reduced rigor/pace mathematics courses (algebra 1 that is spread over two academic years, and "informal geometry").
Middle academic I	Completed two years of mathematics including algebra 1 and geometry, or two years of unified mathematics.[15]
Middle academic II	An additional year of mathematics was completed including algebra 2 or a third year of a unified mathematics program.
Advanced academic	Took at least one of any courses labeled as - "advanced," including various trigonometry, probability, statistics, introductory analysis or precalculus, algebra 3, or calculus courses.

[15]Unified mathematics is a sequence of integrated mathematics courses covering algebra 1, geometry, and algebra 2.

Appendix B—Technical Notes and Methodology

The National Education Longitudinal Study of 1988

The National Education Longitudinal Study of 1988 (NELS:88) is a survey that began with a nationally representative sample of 1988 eighth graders and followed them every two years. The most recent follow-up survey occurred in 1994. Respondents' teachers and schools were also surveyed in 1988, 1990, and 1992, while parents were surveyed in 1988 and 1992. In contrast to previous longitudinal studies, NELS:88 began with eighth graders in order to collect data regarding the transition from elementary to secondary education. The first follow-up in 1990 provided the data necessary to understand the transition. Dropouts were administered a special survey to understand the dropout process more thoroughly. For the purpose of providing a comparison group to 1980 sophomores surveyed in High School and Beyond, the NELS:88 sample was also "freshened" with new participants who were tenth graders in 1990.

In spring of 1992, when most of the NELS:88 sample were twelfth graders, the second follow-up took place. This survey focused on the transition from high school to the labor force and postsecondary education. The sample was also "freshened" in order to create a representative sample of 1992 seniors for the purpose of conducting trend analyses with the 1972 and 1982 senior classes (NLS-72 and HS&B). Students identified as dropouts in the first follow-up were also resurveyed in 1992. In spring of 1994, the third follow-up was administered. Sample members were questioned about their labor force and postsecondary experiences, and family formation. For more information about the NELS:88 survey, consult the NELS:88/94 Methodology Report.[16]

Accuracy of Estimates

The statistics in this report are estimates derived from a sample. Two broad categories of error occur in such estimates: sampling and nonsampling errors. Sampling errors occur because observations are made only on samples of students, not on entire populations. Nonsampling errors occur not only in sample surveys but also in complete censuses of entire populations. Non-

[16]U.S. Department of Education, National Center for Education Statistics, *National Education Longitudinal Study (NELS:88/94) Methodology Report* (NCES 96–174) (Washington D.C.: 1996).

sampling errors can be attributed to a number of sources: inability to obtain complete information about all students in all institutions in the sample (some students or institutions refused to participate, or students participated but answered only certain items); ambiguous definitions; differences in interpreting questions; inability or unwillingness to give correct information; mistakes in recording or coding data; and other errors of collecting, processing, sampling, and imputing missing data.

Data Analysis System

The estimates presented in this report were produced using the NELS:88/94 Data Analysis System (DAS). The DAS software makes it possible for users to specify and generate their own tables from the NELS:88/94 data. With the DAS, users can replicate or expand upon the tables presented in this report. In addition to the table estimates, the DAS calculates proper standard errors and weighted sample sizes for these estimates.[17] For example, table B1 contains standard errors that correspond to table 2 in the text, and was generated by the DAS. If the number of valid cases is too small to produce a reliable estimate (less than 30 cases), the DAS prints the message "low-N" instead of the estimate.

In addition to tables, the DAS will also produce a correlation matrix of selected variables to be used for linear regression models. Included in the output with the correlation matrix are the design effects (DEFTs) for each variable in the matrix. Since statistical procedures generally compute regression coefficients based on simple random sample assumptions, the standard errors must be adjusted with the design effects to take into account the NELS:88 stratified sampling method. (See discussion under "Statistical Procedures" below for the adjustment procedure.)

The DAS can be obtained electronically from the NCES website (NCES.ed.gov) or from the West Coast "mirror site" (PEDAR-DAS.org). For more information about the NELS:88/94 Data Analysis System, contact:

Aurora D'Amico
NCES Data Development and Longitudinal Studies Group
555 New Jersey Avenue, NW
Washington, DC 20208-5652
(202) 219-1365
Internet address: Adamico@ed.gov

[17]The NELS:88/94 sample is not a simple random sample and, therefore, simple random sample techniques for estimating sampling error cannot be applied to these data. The DAS takes into account the complexity of the sampling procedures and calculates standard errors appropriate for such samples. The method for computing sampling errors used by the DAS involves approximating the estimator by the linear terms of a Taylor series expansion. The procedure is typically referred to as the Taylor series method.

Table B1—Standard errors for text table 6: Percentage distribution of 1992 high school graduates who took algebra in the eighth grade, by highest level of mathematics courses completed in high school, first-generation status, and eighth-grade mathematics proficiency

	Mathematics course sequence			
	No mathematics/ low or nonacademic	Middle academic I (algebra 1 and geometry)	Middle academic II (algebra 2)	Advanced academic (beyond algebra 2)[1]
		Took algebra in eighth grade		
Total	0.5	0.6	0.7	0.9
Mathematics proficiency in 1988[2]				
Below level 1	1.8	1.9	1.6	1.8
Level 1	0.9	1.1	1.3	1.0
Level 2	0.7	1.0	1.5	1.6
Level 3	0.2	0.6	1.1	1.2
		First-generation		
Total	1.2	1.2	1.2	1.2
Below level 1	2.8	2.8	2.3	1.4
Level 1	1.7	2.1	2.2	1.6
Level 2	2.0	2.6	2.7	2.9
Level 3	0.6	2.0	3.5	3.8
		Parents have some college		
Total	0.7	0.9	1.0	1.1
Below level 1	2.7	3.0	2.2	1.5
Level 1	1.0	1.5	1.5	1.5
Level 2	1.0	1.5	2.6	2.4
Level 3	0.4	1.4	1.6	2.1
		Parents have bachelor's or advanced degree		
Total	0.7	0.8	1.1	1.4
Below level 1	3.0	4.2	4.8	7.1
Level 1	2.6	2.6	2.4	2.6
Level 2	0.5	1.2	2.2	2.4
Level 3	0.1	0.6	1.4	1.6

[1]Completed at least one class beyond algebra 2 labeled "advanced" including precalculus, calculus, trigonometry, probability, statistics, algebra 3, etc.

[2]Level 1: Can perform simple arithmetical operations on whole numbers. Level 2: Can perform simple operations with decimals, fractions, roots. Level 3: Can perform simple problem solving requiring conceptual understanding or the development of a solution strategy.

SOURCE: U.S. Department of Education, National Center for Education Statistics, National Education Longitudinal Study: 1988–94 (NELS:88), Data Analysis System.

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Statistical Procedures

Two types of statistical procedures were employed in this report: testing differences between means, and adjustment of means after controlling for covariation among a group of variables. Each procedure is described below.

Differences Between Means

The descriptive comparisons were tested in this report using Student's *t* statistic. Differences between estimates are tested against the probability of a Type I error,[18] or significance level. The significance levels were determined by calculating the Student's *t* values for the differences between each pair of means or proportions and comparing these with published tables of significance levels for two-tailed hypothesis testing.

Student's *t* values may be computed to test the difference between estimates with the following formula:

$$t = \frac{E_1 - E_2}{\sqrt{se_1^2 + se_2^2}} \qquad (1)$$

where E_1 and E_2 are the estimates to be compared and se_1 and se_2 are their corresponding standard errors. This formula is valid only for independent estimates. When estimates are not independent, a covariance term must be added to the formula:

$$\frac{E_1 - E_2}{\sqrt{se_1^2 + se_2^2 - 2(r)se_1\ se_2}} \qquad (2)$$

where *r* is the correlation between the two estimates.[19] This formula is used when comparing two percentages from a distribution that adds to 100. If the comparison is between the mean of a subgroup and the mean of the total group, the following formula is used:

$$\frac{E_{sub} - E_{tot}}{\sqrt{se_{sub}^2 + se_{tot}^2 - 2p\,se_{sub}^2}} \qquad (3)$$

[18]A Type I error occurs when one concludes that a difference observed in a sample reflects a true difference in the population from which the sample was drawn, when no such difference is present.

[19]U.S. Department of Education, National Center for Education Statistics, *A Note from the Chief Statistician*, no. 2, 1993.

where p is the proportion of the total group contained in the subgroup.[20] The estimates, standard errors, and correlations can all be obtained from the DAS.

There are hazards in reporting statistical tests for each comparison. First, comparisons based on large t statistics may appear to merit special attention. This can be misleading, since the magnitude of the t statistic is related not only to the observed differences in means or percentages but also to the number of students in the specific categories used for comparison. Hence, a small difference compared across a large number of students would produce a large t statistic.

A second hazard in reporting statistical tests for each comparison occurs when making multiple comparisons among categories of an independent variable. For example, when making paired comparisons among different levels of income, the probability of a Type I error for these comparisons taken as a group is larger than the probability for a single comparison. When more than one difference between groups of related characteristics or "families" are tested for statistical significance, one must apply a standard that assures a level of significance for all of those comparisons taken together.

Comparisons were made in this report only when $p \leq .05/k$ for a particular pairwise comparison, where that comparison was one of k tests within a family. This guarantees both that the individual comparison would have $p \leq .05$ and that for k comparisons within a family of possible comparisons, the significance level for all the comparisons will sum to $p \leq .05$.[21]

For example, in a comparison of the percentages of students who had taken advanced mathematics courses in high school with those who had not with respect to whether or not they enrolled in college, only one comparison is possible (advanced courses versus no advanced courses). In this family, k=1, and the comparison can be evaluated without adjusting the significance level. When students are divided into three parent education groups and all possible comparisons are made, then k=3 and the significance level of each test must be $p \leq .05/3$, or $p \leq .017$. The formula for calculating family size (k) is as follows:

$$k = \frac{j(j-1)}{2} \qquad (4)$$

[20] Ibid.

[21] The standard that $p \leq .05/k$ for each comparison is more stringent than the criterion that the significance level of the comparisons should sum to $p \leq .05$. For tables showing the t statistic required to ensure that $p \leq .05/k$ for a particular family size and degrees of freedom, see Olive Jean Dunn, "Multiple Comparisons Among Means," *Journal of the American Statistical Association* 56 (1961): 52–64.

where j is the number of categories for the variable being tested. In the case of parents' education, there are three groups (first generation, some college, and college graduates), so substituting 3 for j in equation 4,

$$k = \frac{3(3-1)}{2} = 3$$

Adjustment of Means to Control for Background Variation

Tabular results are limited by sample size when attempting to control for additional factors that may account for the variation observed between two variables. For example, when examining the percentages of those who completed a degree, it is impossible to know to what extent the observed variation is due to socioeconomic status (SES) differences and to what extent it is due to differences in other factors related to SES, such as type of institution attended, intensity of enrollment, and so on. However, if a nested table were produced showing SES within type of institution attended, within enrollment intensity, the cell sizes would be too small to identify the patterns. When the sample size becomes too small to support controls for another level of variation, one must use other methods to take such variation into account.

To overcome this difficulty, multiple linear regression was used to obtain means that were adjusted for covariation among a list of control variables.[22] Adjusted means for subgroups were obtained by regressing the dependent variable on a set of descriptive variables such as parents' education, students' academic preparation, students' educational aspirations, etc. Substituting ones or zeros for the subgroup characteristic(s) of interest and the mean proportions for the other variables results in an estimate of the adjusted proportion for the specified subgroup, holding all other variables constant. For example, consider a hypothetical case in which two variables, race/ethnicity and income, are used to describe an outcome, $\hat{Y}$ (such as attending a four-year college). The variables race/ethnicity and family income are recoded into a dummy variable representing race/ethnicity and a dummy variable representing family income:

[22]For more information about weighted least squares regression, see Michael S. Lewis-Beck, *Applied Regression: An Introduction*, Vol. 22 (Beverly Hills, CA: Sage Publications, Inc., 1980); William D. Berry and Stanley Feldman, *Multiple Regression in Practice*, Vol. 50 (Beverly Hills, CA: Sage Publications, Inc., 1987).

Race/ethnicity	*R*
Black students	1
Non-black students	0
and	
Family income	*F*
Low income	1
Not low-income	0

The following regression equation is then estimated from the correlation matrix output from the DAS:

$$\hat{Y} = a + b_1R + b_2F \quad (5)$$

To estimate the adjusted mean for any subgroup evaluated at the mean of all other variables, one substitutes the appropriate values for that subgroup's dummy variables (1 or 0) and the mean for the dummy variable(s) representing all other subgroups. For example, suppose we had a case where Y was being described by race/ethnicity (*R*) and family income (*F*), coded as shown above, and the means for *R* and *F* are as follows:

Variable	Mean
R	0.109
F	0.282

Suppose the regression equation results in:

$$\hat{Y} = 0.51 + (0.032)R + (-0.21)F$$

To estimate the adjusted value for black students, one substitutes the appropriate parameter values into equation 5.

Variable	Parameter	Value
a	0.510	—
R	0.032	1.000
F	-0.210	0.282

This results in:

$$\hat{Y} = 0.51 + (0.032)(1) + (-0.21)(0.282) = 0.48$$

In this case the probability of attending a four-year college for black students is 0.48 and represents the expected outcome for black students who look like the average student across the other variables (in this example, family income). In other words, the adjusted percentage who enrolled in a four-year college is 48 percent (0.48 x 100 for conversion to a percentage).

It is relatively straightforward to produce a multivariate model using the DAS, since one of the DAS output options is a correlation matrix, computed using pairwise missing values.[23] This matrix can be used by most statistical software packages as the input data for least-squares regression. That is the approach used for this report, with an additional adjustment to incorporate the complex sample design into the statistical significance tests of the parameter estimates (described below). For tabular presentation, parameter estimates and standard errors were multiplied by 100 to match the scale used for reporting unadjusted and adjusted percentages.

Most statistical software packages assume simple random sampling when computing standard errors of parameter estimates. Because of the complex sampling design used for the NELS:88/94 survey, this assumption is incorrect. A better approximation of their standard errors is to multiply each standard error by the average design effect of the dependent variable (DEFT),[24] where the DEFT is the ratio of the true standard error to the standard error computed under the assumption of simple random sampling. It is calculated by the DAS and produced with the correlation matrix.

[23]Although the DAS simplifies the process of making regression models, it also limits the range of models. Analysts who wish to use other than pairwise treatment of missing values or to estimate probit/logit models (which are the most appropriate for models with categorical dependent variables) can apply for a restricted data license from NCES. See John H. Aldrich and Forrest D. Nelson, *Linear Probability, Logit and Probit Models* (Quantitative Applications in the Social Sciences, Vol. 45) (Beverly Hills, CA: Sage University Press, 1984).

[24]The adjustment procedure and its limitations are described in C. J. Skinner, D. Holt, and T.M.F. Smith, eds., *Analysis of Complex Surveys* (New York: John Wiley & Sons, 1989).

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